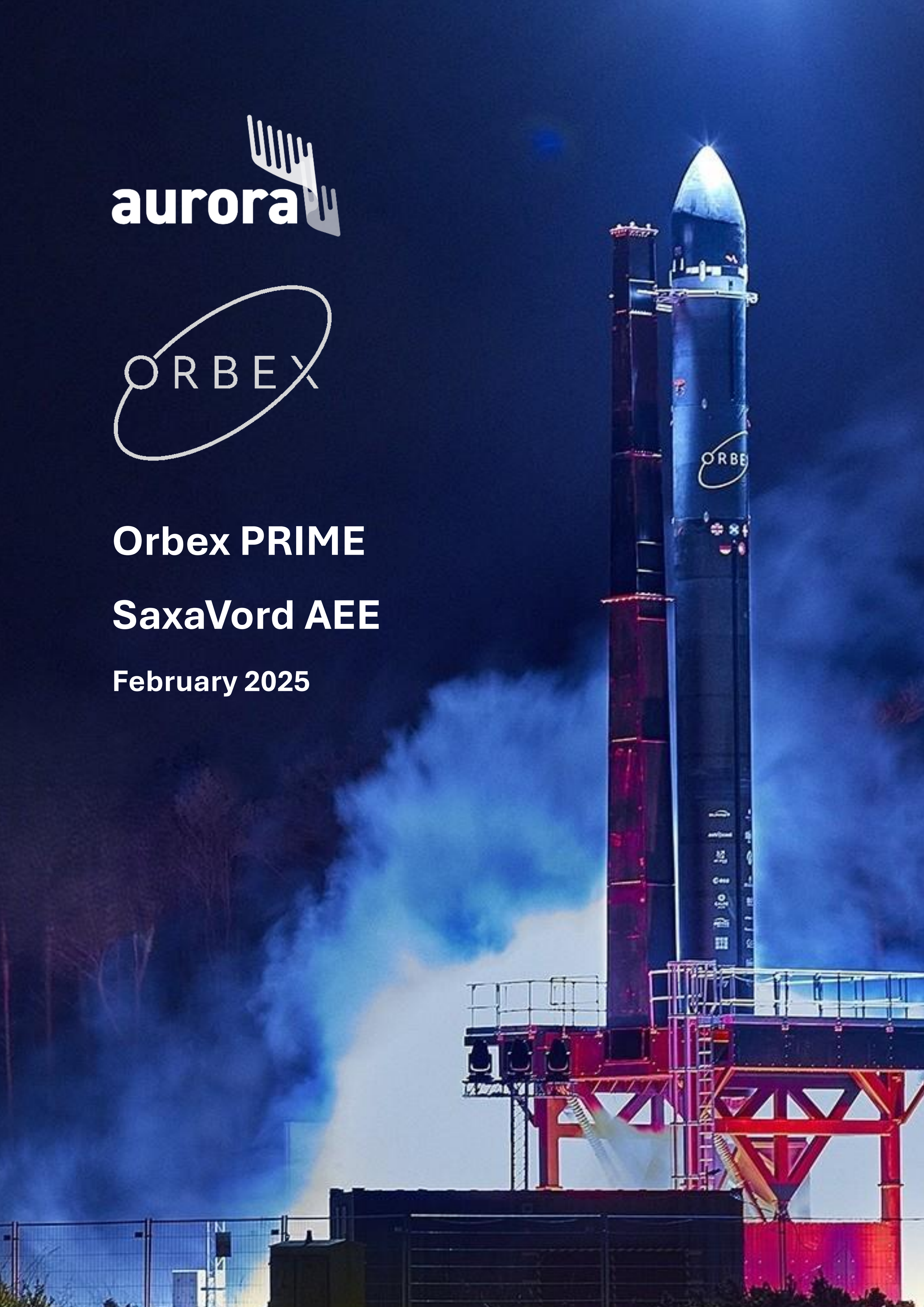

Orbex PRIME

SaxaVord AEE

February 2025

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Abbreviations and Glossary

Abbreviations & Glossary
Orbex PRIME SaxaVord AEE V1

Term	Expanded Term
AD	Alert Distance
AEE	Assessment of Environmental Effects
AIS	Automatic Identification Systems
Al	Aluminium
AOB	Apparently Occupied Burrow
AOS	Apparently Occupied Site
AQAL	Air Quality Assessment Level
AQAP	Air Quality Action Plan
AQIA	Air Quality Impact Assessment
AQMA	Air Quality Management Area
AQOS	Air Quality Objectives
AQS	Air Quality Standard
BBPP	Breeding Birds Protection Plan
CAA	Civil Aviation Authority
CAFF	Conservation of Arctic Flora and Fauna
CCP	Scottish Government Climate Change Plan
CFRP	Carbon Fibre Reinforced Plastic
CIEEM	Chartered Institute for Ecology and Environmental Management
CIRIA	Construction industry research information association
CO	Carbon monoxide
CO_2	Carbon dioxide
Cu	Copper
dB	Decibel
DfT	Department for Transport
EC	European Commission
EcIA	Ecological Impact Assessment
ECoW	Ecological Clerk of Works
EEZ	Exclusive Economic Zone
EIAR	Environmental Impact Assessment Report
EMODnet	European Marine Observation and Data Network
EPS	Environmental Protection Scotland
EPS	European Protected Species

Term	Expanded Term
EPUK	The Environmental Protection UK
EZI	Environmental Zone of Influence
FAA	Federal Aviation Administration
FCS	Favourable Conservation Status
FID	Flight Initiation Distance
FTS	Flight Termination System
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GSE	Ground Support Equipment
GVA	Gross Value Added
GWDTE	Groundwater Dependent Terrestrial Ecosystem
Ha	Hectare
HDPE	High Density Polyethylene
He	Helium
HEPA	High Efficiency Particulate Air (Filter)
HES	Historic Environment Scotland
HRAs	Habitats Regulations Assessments/Appraisals
HVAC	Heating Ventilation and Air Conditioning (System)
IAQM	Institute of Air Quality Management
ICES	International Council for Exploration of the Seas
IEMA	Institute of Environmental Management and Assessment
JNCC	Joint Nature Conservation Committee
LA	Local Authority
LAQM	Local Air Quality Management
LBAP	Living Shetland Local Biodiversity Action Plan
LEZ	Launch Exclusion Zone
LNLS	Lamba Ness Launch Site
LOX	Liquid Oxygen
LPG	Liquified Petroleum Gas
LULUCF	Land Use / Land Use Change Factor
LVIA	Landscape and Visual Impact Assessment
MCA	Maritime and Coastguard Agency
MCMS	Marine Case Management System
MERA	Marine Environmental Risk Assessment
MMO	Marine Management Organisation
MPA	Marine Protected Areas

Term	Expanded Term
MPAs	Marine Protected Areas
NAMMCO	North Atlantic Marine Mammal Commission
NAQS	National Air Quality Strategy
NBN	National Biodiversity Network
NEAFC	North East Atlantic Fisheries Commission
NHZ	Natural Heritage Zone
NIRs	Natura Impact Reports
NISs	Natura Impact Statements
NIWA	National Institute of Water and Atmospheric Research Ltd
NO_2	Nitrogen Dioxide
NOAA	National Oceanic and Atmospheric Administration
NPF	National Planning Framework
NSR	Noise Sensitive Receptor
NTS	Non-Technical Summary
NVC	National Vegetation Classification
OEMP	Operational Environmental Management Plan
OPP	Otter Protection Plan
OTV	Orbital Transfer Vehicle
PAHs	Polycyclic Aromatic Hydrocarbons
PAN	Planning Advice Note
PBDEs	Polybrominated Diphenyl Ethers
PCA	Peatland Condition Assessment
PCBs	Polychlorinated Biphenyls
PPE	Personal Protective Equipment
PTFE	Polytetrafluoroethylene
RCP	Representative Concentration Pathway
Red L	UK Birds of Conservation Concern Red List Species
RIES	Reports on the Implications for European Sites
RP-1	Rocket Propellant 1
RSPB	Royal Society for the Protection of Birds
RTPI	Royal Town Planning Institute
SAC	Special Area of Conservation
Sas	Sustainability Appraisals
SBL	Scottish Biodiversity List
SBS	Scottish Biodiversity Strategy
SEAs	Strategic Environmental Assessments

Term	Expanded Term
SEPA	Scottish Environment Protection Agency
SIC	Shetland Islands Council
SNH	NatureScot (previously Scottish Natural Heritage)
SSO	Sun synchronous orbit
SSSI	Site of Special Scientific Interest
SST	Sea Surface Temperature
SWBSG	Scottish Windfarm Bird Steering Group
TAN	Technical Advice Note
tCO_2e	Tonnes of carbon dioxide equivalent
The Applicant	Orbital Express Lauch Limited
UNCLOS	United Nations Convention on the Law of the Sea
VME	Vulnerable Marine Ecosystem
WFDA	Water Framework Directive Assessment
WHO	World Health Organisation Guideline Value

Glossary

AEE	**Assessment of Environmental Effects** The systematic process of identifying, quantifying and evaluating the potential effects of the proposed activities on the environment. The purpose of AEE is *'to ensure that applicants for spaceport licences have considered the potential environmental effects of their intended activities and, if necessary, taken appropriate and proportional steps to avoid, mitigate or offset the risks and their potential effects'*. (CAA et. al. 2021).
AQMA	**Air Quality Management Area** Since December 1997 each local authority in the UK has been carrying out a review and assessment of air quality in their area. This involves measuring air pollution and trying to predict how it will change in the next few years. The aim of the review is to make sure that the national air quality objectives will be achieved throughout the UK by the relevant deadlines. These objectives have been put in place to protect people's health and the environment. If a local authority finds any places where the objectives are not likely to be achieved, it must declare an Air Quality Management Area there. This area could be just one or two streets, or it could be much bigger. Then the local authority will put together a plan to improve the air quality - a Local Air Quality Action Plan.
AQS	**Air Quality Strategy** This strategy sets out the comprehensive actions required across all parts of government and society to improve airy quality. The strategy sets out how we will protect the nation's health and protect the environment.
BBPP	**Breeding Bird Protection Plan** All birds, their nests and eggs are protected by the Wildlife & Countryside Act 1981 as amended by the Nature Conservation (Scotland) Act 2004.
EZI	**Environmental Zone of Influence** The Environmental zone of influence is the area whose environmental features could be affected by the specific launch(es) to be carried out under the prospective licence.
FCS	**Favourable Conservation Status** Conservation Status will be taken as Favourable when population dynamics data on the species concerned indicate that it is maintaining itself on a long-term basis as a viable component of its natural habitats, and the natural range of the species is neither being reduced nor is likely to be reduced.
FID	**Flight Initiation Distance** The distance at which a bird flees from perceived danger is defined as the flight initiation distance and could be used to designate separation distances between birds and stimuli that might cause disturbances.
Flight Corridor	**Flight Corridor** An area on the Earth's surface estimated to contain the hazardous debris from nominal flight of a launch vehicle and off-nominal flight of a launch vehicle, assuming a functioning flight termination system or other flight safety system.

GPPs	**Guidance for Pollution Prevention** GPPs provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales only.
GWDTE	**Groundwater Dependent Terrestrial Ecosystems** Groundwater Dependent Terrestrial Ecosystems (GWDTE) are wetlands which critically depend on groundwater flows or chemistries. As part of the assessment of groundwater status you have to assess if it has been significantly damaged and if the pressure causing this damage has happened via a groundwater body.
Impact	**Impact** The change experienced by a receptor (this can be beneficial, neutral or adverse)
Launch Azimuth	**Launch Azimuth** The horizontal angular direction initially taken by a launch vehicle at lift-off, measured clockwise in degrees from true north.
Launch Vehicle	**Launch Vehicle** A launch vehicle or carrier rocket is a rocket propelled vehicle used to carry a payload from Earth's surface to space usually to Earth orbit or beyond.
LBAP	**Local Biodiversity Action Plan** Local Biodiversity Action Plan Partnerships operate at the local authority level. They were set up in the UK following the Rio Earth Summit in 1992 in response to the UK becoming a signatory to the Convention on Biological Diversity. Most local authorities work in partnership with both national environmental agencies and local biodiversity organisations to deliver local biodiversity action plans. Either the local authority employs a dedicated biodiversity officer or, as part of other posts in the local authority, an officer supports the partnership.
Nominal	**Nominal** In reference to launch vehicle performance, trajectory, or stage impact point, a launch vehicle flight where all launch vehicle aerodynamic parameters are as expected, all vehicle internal and external systems perform as planned, and there are no external perturbing influences (e.g., winds) other than atmospheric drag and gravity.
NMPI	**National Marine Plans Interactive** Is an interactive tool which is part of the Marina Scotland Open Data Network and has been designed to assist in the development of national and regional marine planning. Allows you to view different types of information and, where appropriate, links have been provided to the related parts of Scotland's Marina Atlas, the National Marina Plan as well as links to data sources to facilitate data download.
Off-nominal Launch Event	**Off-nominal Launch Event** A launch event where the launch event proceeds beyond ignition but does not perform within expected/acceptable limits.

Orbital	**Orbital** Connected with the orbit of a planet (Earth) or object in space. In relation to launch vehicles - An orbital launch vehicle is used to deliver a payload from our planet into the Earth's orbit.
Receptor	**Receptor** Used throughout the AEE process and is defined as the element in the environment affected by a development (e.g., a bird in the case of ornithology)
SLM	**Sound Level Meter** Used for acoustic measurements, commonly handheld with a microphone. They provide readings on the noise level in an environment and usually return a measurement in decibels (dB).
SPA	**Special Protection Areas** A Special Protection Area is a designation under the European Union Directive on the Conservation of wild birds. Under the Directive, Member States of the European Union (EU) have a duty to safeguard the habitats of migratory birds and certain particularly threatened birds.
Space activity	**Space activity** Space activities are defined as: (a) launching or procuring the launch or the return to earth of a space object or of an aircraft carrying a space object (b) operating a space object, or (c) any activity in outer space They are also referred to as 'spaceflight activities'.
Spacecraft	**Spacecraft** A space object, a rocket or other craft that is capable of operating above the stratosphere or a balloon that is capable of reaching the stratosphere carrying crew or passengers, that is used for spaceflight activities. It includes satellites.
Space Object	**Space Object** The component parts of a space object, its launch vehicle and the component parts of that.
SPP	**Scottish Planning Policy** A statement of Scottish Government Policy on how nationally important land use planning matters should be addressed across the country.
SSSI	**Site of Special Scientific Interest** A Site of Special Scientific Interest (SSSI) is a formal conservation designation. Usually, it describes an area that's of particular interest to science due to the rare species of fauna or flora it contains - or even important geological or physiological features that may lie in its boundaries.
SST	**Sea Surface Temperature** Sea surface temperature (SST) is the water temperature close to the ocean's surface. The exact meaning of surface varies according to the measurement method used, but it is between 1 millimetre (0.04 in) and 20 metres (70 ft) below the sea surface.

Sub-orbital	**Sub-orbital** Suborbital flights may go into space, then their path (or trajectory) carries them back to earth.
Sub-orbital activity	**Sub-orbital activity** Launching, procuring the launch of, operating or procuring the return to earth of: (a) a rocket or other craft that is capable of operating above the stratosphere (b) a balloon that is capable of reaching the stratosphere carrying crew or passengers, or (c) an aircraft carrying such a craft but does not include space activity. The regulator uses the International Standard Atmosphere (47km) as the stratopause for the purposes of determining whether an activity is ‘sub-orbital’.
TAN	**Technical Advice Note** Technical Advice Notes provide guidance which may assist in the technical evaluation of noise assessment.
Test Launch	**Test Launch** A research/test launch event that proceeds beyond ignition and lift off.
Trajectory	**Trajectory** The position and velocity components as a function of time of a launch vehicle relative to an x, y, z coordinate system, expressed in x, y, z, $\dot{x}$, $\dot{y}$, $\dot{z}$.
UKVEA	**Upper Exposure Action Value** The upper exposure action value is set at a daily or weekly average noise exposure of 85 dB, above which the employer is required to take reasonably practicable measures to reduce noise exposure, such as engineering controls or other technical measures.
WHO	**World Health Organisation** WHO’s primary role is to direct international health within the United Nations’ system and to lead partners in global health responses.

Volume I Non-Technical Summary

Non-Technical Summary

1. Non-Technical Summary

1.1 Introduction

1.1.1 Aurora Environmental Consulting Limited (Aurora) has prepared this Assessment of Environmental Effects Report (AEE Report) on behalf of Orbital Express Launch Limited ('the Applicant') regarding their application to the Civil Aviation Authority (the regulator) for a licence under the Space Industry Act 2018.

1.1.2 The Applicant intends to launch Orbex PRIME Launch Vehicles on sub-orbital and orbital trajectories from Launch Pad 3 at SaxaVord Spaceport, located at Lamba Ness in Unst, Shetland, and as such is applying to the UK Civil Aviation Authority (CAA) for a launch operator licence. The licence application will seek permission for up to 10 Orbex PRIME Launch Vehicle launches per year for 30 years; covering both sub-orbital and orbital launches.

1.1.3 As set out in the National Space Policy (UK Government 2018) and the later National Space Strategy (UK Government, 2021), the UK aims to become the European hub for commercial spaceflight and related sector technologies. The UK Government is committed to building one of the most innovative and attractive space economies in the world, supporting the growth of a robust and competitive commercial space sector growing the value of the UK Space Sector to £40 billion by 2030, representing approximately 10% of the global market.

1.1.4 The Applicant's primary goal is to support the space industry by providing access to space. In Orbex PRIME, the company has developed one of the most advanced, low carbon, high performance micro-launch vehicles in the world.

Space Industry Act 2018

1.1.5 The Space Industry Act 2018 received Royal Assent on 15 March 2020 and provides a legal framework for the licensing of space activities, sub-orbital activities and associated activities carried out in the UK.

1.1.6 The Act requires that any person or organisation wishing to undertake the following to obtain a relevant licence:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities form the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

1.1.7 As the Applicant wishes to become a spaceflight operator and launch Orbex PRIME Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the Proposed Project.

Space Industry Regulations 2021

1.1.8 The Space Industry Regulations 2021 (the Regulations) sets out in more detail the requirements for each licence and the regulators licensing rules, which specify what information the CAA, the regulator, requires in support of an application.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

1.1.9 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note ‘CAP2215 Guidance for the Assessment of Environmental Effects’ in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

1.1.10 The guidance describes the licence required by the Applicant as follows:

- *A launch operator licence means an operator licence within section 3 of the Act which authorises a person or organisation to carry out spaceflight activities... A person or organisation holding a launch operator licence is referred to as a spaceflight operator, or in some circumstances, launch operator licensee. If a launch operator licensee wishes to return a launch vehicle launched from the UK or the UK’s territorial waters to land in the UK, it can apply to do so under the launch operator licence and does not need to apply for a separate return operator licence.*

1.1.11 AEE is relevant to applications for launch operator licences and so this document has been prepared in support of the launch operator licence application.

Guidance to the Regulator on Environmental Objectives relating to the Exercise of its Functions under the Space Industry Act 2018

1.1.12 The Department for Transport issued its document ‘Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018’ in 2021, clarifying the government’s environmental objectives relating to spaceflight and associated activities in the UK:

1.1.13 The environmental objectives for spaceflight are to:

- Minimise emissions contributing to climate change resulting from spaceflight activities;
- Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;
- Protect people and wildlife from the impacts of noise from spaceflight activities;
- Protect the marine environment from the impact of spaceflight activities.

1.1.14 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE. Consideration of the environmental objectives has been included as relevant in the AEE technical assessment chapters.

Location

1.1.15 The Proposed Project will operate from the SaxaVord Spaceport Lamba Ness Launch Site (LNLS) in Unst, the most northerly of the Shetland Islands.

1.1.16 For the purposes of this AEE, the boundary of the Proposed Project has been assumed as the areas within SaxaVord Spaceport where the delivery, preparation and launch of the Orbex PRIME Launch Vehicle will take place. The Proposed Project site boundary is shown on Drawing 3.1 in Volume III, centred on national grid reference 466470 E, 121550 N and occupies an area of approximately 28 hectares. It is approximately 2.5 km north-east of the settlement of Norwick.

1.2 Approach to AEE

1.2.1 AEE is the systematic process of identifying, quantifying, and evaluating the potential effects of the proposed activities on the environment. Where appropriate, the AEE report sets out mitigation measures designed to prevent, reduce and, if at all possible, offset potentially significant effects.

1.2.2 As required by the CAA guidance, this launch operator AEE covers all operations and activities intended to be carried out that may have an environmental effect. Effects on the following environmental features have been considered:

- Population and human health;
- Biodiversity (ecology and ornithology);
- Air quality;
- Noise and vibration;
- Water;
- Climate;
- Marine environment;
- Land, Soils and Peat;
- Landscape, Seascape and Visual Impact;
- Material Assets and Cultural Heritage; and
- Accidents and Disasters.

1.2.3 Of these, due to the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the Orbex PRIME Launch Vehicle will not have significant effect on land condition due to the SaxaVord Spaceport infrastructure already in place, it is considered that the Proposed Project has no potential for significant effects on either the water environment or the condition of underlying land, soils or peat. As such, these elements have not been considered further within this AEE.

1.2.4 As the specification of the Orbex PRIME Launch Vehicle is within the limiting case envelope assessed for SaxaVord Spaceport (i.e., launches of sub-orbital sounding rockets and small satellites into either polar or sun-synchronous, low-earth orbits by multiple launch service providers using a range of different Launch Vehicle types up to 30 m in height), it is considered that no further assessment of visual impact is required on top of that previously submitted in the SaxaVord spaceport operator licence application AEE (reference SR-APP-001019). As such, landscape and visual assessment has not been considered further within this AEE.

1.2.5 Similarly, it is considered that assessment of population effects is not required as the Proposed Project is within the limiting case envelope assessed for SaxaVord Spaceport - sub-orbital and orbital launches of small satellites into either polar or sun-synchronous, low-earth orbits. As such the assessment of population effects completed for the SaxaVord Spaceport AEE is considered appropriate to this AEE.

1.2.6 Due to the small number of launches proposed by the Applicant (maximum of 10 per year), the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the Orbex PRIME Launch Vehicle will not have significant effect on material assets and cultural heritage due to the SaxaVord Spaceport infrastructure already in place, it is considered that the Proposed Project in isolation has no potential for significant effects on material assets and cultural heritage. As such, these elements have not been considered further in this AEE.

1.3 Proposed Project

1.3.1 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicle from Launch Pad 3 at SaxaVord Spaceport Lamba Ness Launch Site (LNLS) situated on the Lamba Ness peninsula in Unst, Shetland. The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year.

1.3.2 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure and designed to launch payloads of up to 180 kg into both sub-orbital and orbital trajectories.

1.3.3 The environmental zone of interest (EZI) for the Proposed Project is contained between 085 and 100 degrees from the equator.

1.3.4 Orbital launches will take place in a northerly direction from Launch Pad 3 at SaxaVord Spaceport and will only be allowed to occur when meteorological conditions are such that no southerly movement of the Orbex PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences

1.3.5 Sub-orbital launches of the Orbex PRIME Launch Vehicle will take place along a 089.5° azimuth from Launch Pad 3 and will only be allowed to occur when meteorological conditions are such that no southerly movement of the Orbex PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences.

1.3.6 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first launch as soon as Q4 2025 and then increase cadence to 10 launches per year.

1.3.7 Following consultation with NatureScot during the planning application stage for the Spaceport, SaxaVord Spaceport committed to a no-launch window whereby no launches will be carried out between mid-May and the end of June so as to avoid disturbing birds during the critical incubation and early brooding period. The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.

1.3.8 Of the proposed 10 launches per year, when taking into account the no-launch window agreed between mid-May to the end of June, the Applicant anticipates that in any one month there will be a maximum of two launches of the Orbex PRIME Launch Vehicle. Given the proposed frequency of launches and the short duration of the associated noise events adverse effects associated with sleep disturbance due to night-time launches are considered to be minimal.

1.3.9 The location of the Proposed Project is shown on Figure NTS-1.

Figure NTS-1 Location of Proposed Project in Unst, Shetland

1.3.10 The infrastructure required for the Proposed Project is being provided by SaxaVord Spaceport, which is subject to regulation under the Act itself and has completed an AEE as part of its own Spaceport Operator Licence application (document reference LP-004-SAXA, application SR-APP-001019). The Proposed Project layout plan shows the infrastructure of SaxaVord Spaceport and is included as Drawing 3.2 in Volume III.

1.3.11 The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure at the LNLS:

- Launch Pad 3: the most easterly of the three launch pads located on the Lamba Ness peninsula. Launch Pad 3 incorporates ground services storage and control, lightning protection masts, liquid and compressed gas storage and water deluge tanks for launch operations;
- Satellite Tracking Station: an area of hardstanding housing satellite tracking and telemetry devices located on the Lamba Ness peninsula;
- Rocket Hall 2 of Integration Hangar A: the building where the Orbex PRIME Launch Vehicles is assembled and the payload(s) integrated;
- Administration Building and Hazardous Materials Store located adjacent to the LSPF on the LNLS;
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

1.3.12 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first launch as soon as Q4 2025 and then increase cadence to 10 launches per year.

1.3.13 The layout of the Proposed Project, within the context of the wider SaxaVord Spaceport, is shown on Figure NTS-2.

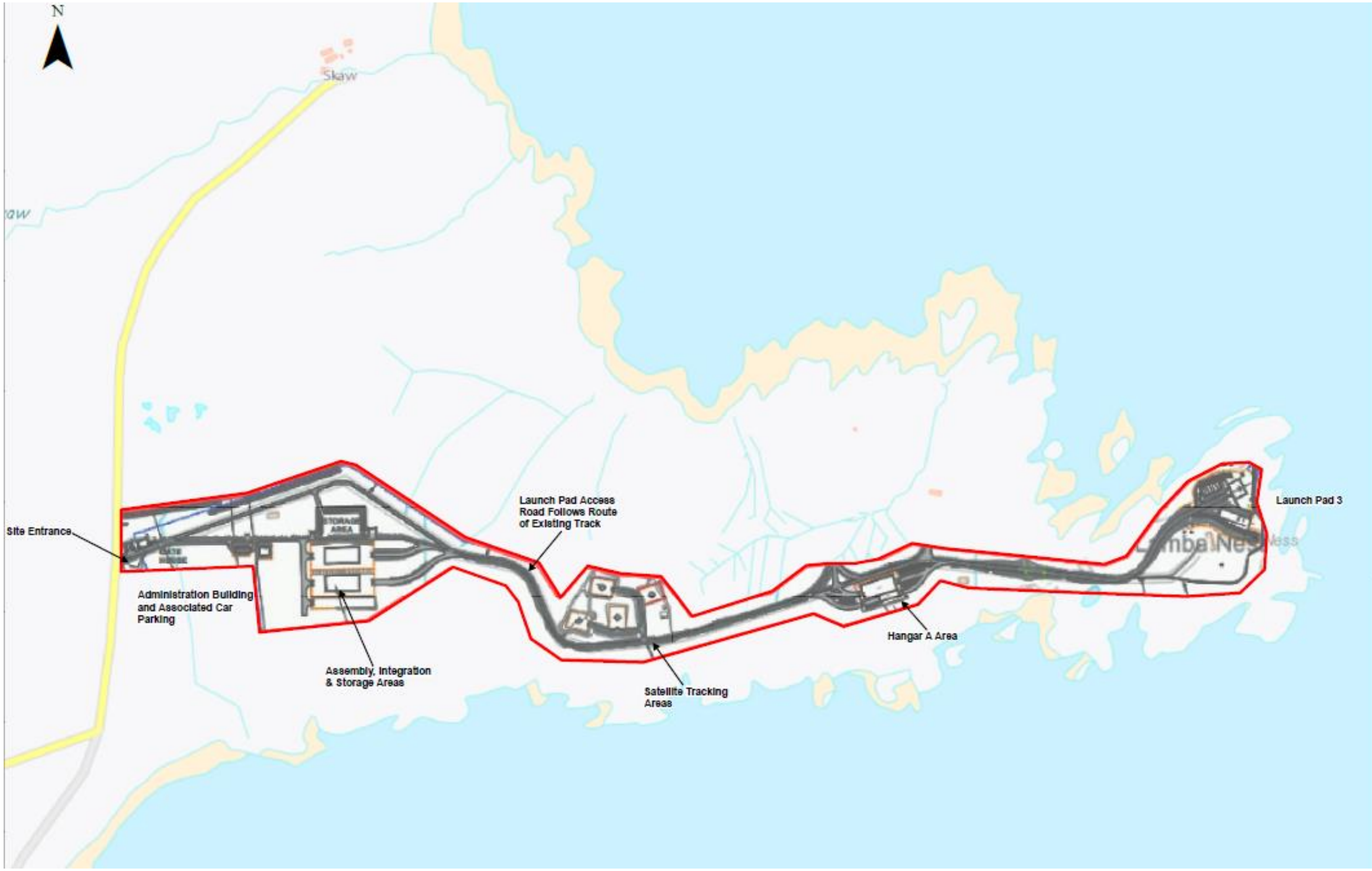

Figure 2 Proposed Project Site Layout

Environmental Budget

1.3.14 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own environmental budget of 30 launches per year.

1.3.15 Whilst the Applicant has not yet determined a specific timeframe for operations, when required for the purposes of this AEE an operational period of 30 years (equating to 300 launches) has been assumed, aligning with the current land lease for SaxaVord Spaceport. This applies in particular to the process of calculating total mass of returning components, required for the Marine and Transboundary assessment.

1.3.16 For other technical disciplines the appropriate timeframe for assessment varies – for example for ecology/ornithology the appropriate timeframe is considered generally to be a year due to breeding seasonality, and similarly cumulative noise effects are assessed over the period of a year. Whereas for air quality, due to the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within a 24-hour period) the appropriate assessment period is considered to be a single launch. Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

1.4 Climate Change

1.4.1 An assessment of the potential effects of greenhouse gas emissions associated with the Proposed Project on climate change has been undertaken. The assessment considered emissions arising from the operation of the Proposed Project including transportation and combustion of Orbex PRIME Launch Vehicle fuel.

1.4.2 A climate resilience assessment has been carried out to assess the vulnerability of the Proposed Project to climate change. The assessment evaluated the impact of climatic variables such as wind speed, precipitation and temperature on sensitive receptors associated with the Proposed Project.

1.4.3 The climate baseline has been characterised using Met Office climate data for the period 1981-2010.

1.4.4 Greenhouse gas emissions in the context of overall annual emissions from the Shetland Islands are considered of minor significance.

1.4.5 Mitigation measures including the investigation of non-fossil alkane substitutes and the continued decarbonisation of passenger and freight transport will contribute to reducing greenhouse gas emissions.

1.4.6 Climate resilience impacts on the Proposed Project associated with high temperatures are considered to be of negligible significance. High wind speeds are predicted to have an effect of minor significance on the Proposed Project. The effects of heavy precipitation on the Proposed Project are considered to be of minor significance.

1.4.7 Standard mitigation has been considered in the inference of effect significance. Committed mitigation measures include suspending activities during extreme weather events.

1.5 Ornithology

1.5.1 Targeted and licensed breeding bird surveys were undertaken following agreed standardised survey methods between 2018 and 2020 (and subsequently for seabirds) within the ornithological study area. A total of 135 bird species were recorded during breeding bird surveys. There was direct evidence of potentially sensitive and specially protected bird species breeding within, and adjacent to, the Proposed Project boundary.

1.5.2 Ornithological designated site interests on the Hermaness, Saxa Vord and Valla Field SPA (and overlapping Hermaness SSSI and Saxa Vord SSSI) and the following non-designated wider countryside ornithological birds are taken forward for assessment: red-throated diver, merlin, black guillemot, common guillemot, puffin, razorbill, shag, kittiwake, fulmar, ringed plover, golden plover, whimbrel, curlew, dunlin, Arctic tern, Arctic skua, great skua and a confidential Schedule 1 species.

1.5.3 To understand potential impacts of loud, short duration noise events, a background literature review of noise impacts on relevant bird species was undertaken. This literature review looked at how impulsive noise (from various sources including aircraft, fireworks, military ranges and rocket launches) impacted on birds in order to help assess the potential noise impacts of the launches.

1.5.4 Potential impacts from the Proposed Project (preparation and launch of the Orbex PRIME Launch Vehicle) have been assessed. The magnitude of predicted operational effects is either ‘no effect’ or ‘negligible’ for all bird species considered except one. Minor operational impacts are predicted for a confidential Schedule 1 breeding species (although there was no evidence of this species recorded during breeding bird surveys in 2022 and subsequently).

1.5.5 Confidential bird species information has been submitted to and assessed previously by the local planning authority, as part of the planning process for the Proposed Project.

1.5.6 All likely effects are assessed as non-significant, apart from a confidential Schedule 1 species, where minor magnitude operational effects are considered likely to be significant in the absence of mitigation.

1.5.7 Confidential bird species information has been submitted to and assessed previously by the local planning authority, as part of the planning process for the Proposed Project.

1.5.8 Mitigation measures inherent to operation of the Proposed Project, as confirmed and implemented through planning conditions for SaxaVord Spaceport, are outlined in Appendix 5.3: Habitat Management Plan and comprise of the following elements that will benefit ornithological receptors: large-scale peatland restoration, creation of native broadleaved riparian woodland, coastal grassland management, off-site red-throated diver lochan habitat restoration/protection, habitat creation for a Schedule 1 breeding bird and whimbrel chick habitat creation.

1.5.9 After mitigation, all residual effects are predicted likely to be not significant.

1.6 Ecology and Biodiversity

1.6.1 Targeted and licensed baseline ecology surveys, following best practice guidance, were undertaken between 2018 and 2020 with updated walkover and pre-construction surveys undertaken in 2022.

1.6.2 The Habitats Study Area is dominated by four Phase 1 habitats: wet modified bog/wet heath, wet modified bog, coastal grassland, and semi-improved acid grassland. The Habitat Study Area was walked over during the summer months in 2022 by the same experienced habitat surveyor that completed the original habitat survey work, and no substantive changes were recorded other than the construction works commencing.

1.6.3 Numerous otter field signs were recorded during targeted surveys in 2018 and 2020. There were six-seven otter holts within the Otter Study Area. The holts were invariably within inaccessible cliff locations, between boulders or inside caves/crevices. Scats and footprints, including those of adults and young, were also recorded in the abandoned buildings across Lamba Ness. Similar evidence of otter holts and otter activity was recorded in the 2022 and July 2024.

1.6.4 Otter use of an underpass was particularly noticeable in all years including 2024. It is considered likely that otters use this underpass as a regular route to cross from the north to south side of Lamba Ness (and vice versa) and so is likely to be functionally important to otter use of the Lamba Ness area.

1.6.5 Potential effects of the Proposed Project on potential receptors have been assessed.

1.6.6 The assessment does not predict any likely significant ecological effects associated with the Proposed Project.

1.7 Air Quality

1.7.1 Consideration has been given to the potential effects of emissions from the Proposed Project on local air quality. Potential impacts have been predicted at representative ecological and human health receptors in proximity to the Proposed Project.

1.7.2 Launch emissions are predicted to have no perceptible impact at any identified receptors under prevailing wind directions. The maximum predicted impact at a sensitive receptor is predicted to occur with east north-easterly winds which occur typically for less than 10% of the year. The maximum predicted 8-hour concentration of CO at a sensitive receptor is 0.66% of the AQS. Emissions from launch events are therefore considered to have a negligible impact on air quality, resulting in no likely significant effect.

1.8 Noise

1.8.1 Potential noise and vibration effects associated with the Proposed Project have been assessed with regard to launches and associated non-launch activities. The assessment of noise and vibration relies primarily on modelling and calculations undertaken by BRRC.

1.8.2 Noise effects associated with road traffic and non-launch activities have been assessed as not significant, resulting in no likely significant effect.

1.8.3 Noise during launches will be audible at noise sensitive receptors (NSRs) within and beyond the noise study area and levels will exceed the criterion for community annoyance associated with aircraft noise. However, the short duration of audible noise 'events' associated with engine tests and launches, and their infrequent occurrence, will reduce the associated levels of annoyance to below that which may be associated with aircraft noise from conventional airports. Accordingly, adverse health effects are not anticipated. Noise at NSRs associated with launches is below the level at which the potential for cosmetic damage to structures is likely. Noise effects launches have therefore been assessed as not significant, resulting in no likely significant effect.

1.8.4 Vibration (air overpressure) associated with launches has been evaluated and found to result in a low likelihood of damage complaints and has therefore been determined to be not significant, resulting in no likely significant effect.

1.8.5 Standard mitigation has been considered in the derivation of effect significance. Committed mitigation measures include a commitment to meeting noise limits for fixed and mobile plant items and assisting SaxaVord Spaceport in maintaining good communications with the local community with regard to all activities of the Proposed Project.

1.9 Accidents and Disasters

1.9.1 A list of potential events was drawn up based on the Proposed Project activities.

1.9.2 Natural disasters including flooding and tectonic activity are considered highly unlikely given the location of the Proposed Project. Extreme weather effects have been addressed in the Climate Change assessment, and it is considered that the proposed infrastructure design provides sufficient resilience to the effects of extreme weather events over the design life of the Proposed Project.

1.9.3 Accident events were subcategorised into failure of containment of propellant and fuel, ignition of fuel and off-nominal launch scenarios. The effects on generic on-site human and wildlife receptors and off-site designated habitat sites were considered for each of these events.

1.9.4 Failures of containment were generally considered to be minor or moderate significance and largely restricted to the areas immediately within the vicinity of the release point, given the quantities in use and the rapid expected evaporation and/or dispersion of the liquids and gases used. Mitigation will be through adherence to the Applicant's own and SaxaVord Spaceport management procedures, robust containment and restrictions on the quantities stored at the Proposed Project.

1.9.5 Again, noting the environmental context, ignition events are considered to be major with potential for significant effects inasmuch as damage to health or loss of life to human and wildlife receptors would be possible if in close proximity to the event. In the unlikely event that ignition of LPG vapour occurred, the deflagration radius or resulting jet or flash fire would be relatively small (likely within the spaceport boundary) and the subsequent blaze limited in duration by the quantities stored and used.

Mitigation will be through the restriction of ignition sources from flammable materials through standard operating practices. Uncontrolled ignition events during launches will be managed through the Orbex PRIME Launch Vehicle design process and integrity checks.

1.9.6 Off-nominal launch scenarios are considered to be of major significance should a ground strike take place, with potential for severe damage to human, wildlife and habitat receptors from impact and subsequent ignition of remaining propellant. Mitigation is inherent to the remote, northerly location of the Proposed Project and exclusively northward launch trajectories to be used. Water strikes were considered of moderate significance as wildlife and marine habitat receptors could potentially be impacted and are discussed in the Marine Effects Chapter of the AEE Report.

1.10 Marine and Transboundary Effects

1.10.1 An assessment of the potential environmental effects associated with the Proposed Project on marine and transboundary receptors has been undertaken.

1.10.2 The proposed trajectories of both sub-orbital and orbital launches of the Orbex PRIME Launch Vehicle will have an overall northerly direction from SaxaVord Spaceport, contained between 085 and 100 degrees from the equator. Considering the impact zone for the payload fairing, up to three impact zones are expected per launch (first stage plus interstage, fairings, and second stage). The impact zones for the first stage, interstage and fairings are expected to occur in marine locations between Scotland and Greenland. The impact zone for the deorbiting second (orbital) stage is anticipated to occur in the South Pacific.

1.10.3 The assessment includes consideration of effects associated with the launch and return to earth of the Orbex PRIME Launch Vehicle.

1.10.4 The South Pacific EZI of the Orbex PRIME Launch Vehicle may overlap with the Exclusive Economic Zones (EEZs) of other countries. In such cases, the second stage will not be released on any trajectory where it will fall within the EEZs of any of these nations unless prior permission is obtained pertinent to the specific launch.

1.10.5 The North Atlantic EZI comprises mostly deep water with a small amount of continental shelf and many bathymetric features. The water quality of the North Atlantic EZI is high, in that it does not have significant local input of anthropogenic contaminants such as metals, microplastics, and hydrocarbons. The North Atlantic EZI supports numerous marine biota such as plankton, benthic habitats, fish and shellfish, seabirds, and marine mammals. The North Atlantic EZI has few marine protected areas.

1.10.6 In the North Atlantic EZI, human activities are concentrated in the southern portion (as far as the Faroe Islands to the north). This includes shipping and navigation, oil and gas cables and pipelines, and commercial fishing. There is occasional use of the area for military activities. Marine archaeology is poorly known and so assumed to be present. There is presence of oil and gas infrastructure, subsea cables and pipelines, marine renewable energy, dredge disposal sites, tourism, and marine archaeological features.

1.10.7 Launches have the potential to affect the aforementioned water quality, biodiversity and human activities. The pathways of effect have been identified: impacts from the presence of the Orbex PRIME Launch Vehicle and associated materials, such as metals, microplastics, and hydrocarbons; impacts from direct strike and impact at the seabed from when the returning components come to rest.

1.10.8 The potential impacts on water quality, biodiversity, and human activities in the North Atlantic EZI have been assessed. All pathways have a negligible or minor risk of a likely significant effect on the receptors. No likely significant effect.

1.10.9 Because the risk is negligible or minor there is no requirement to apply mitigation in order to reduce the risk further. Accordingly, the residual effect to the receptors is also negligible or minor. No likely significant effect.

Volume II AEE Report

Chapter 1 Introduction

1. Introduction

1. Introduction

1.1 Introduction

1.1.1 Aurora Environmental Consulting Limited (Aurora) has prepared this Assessment of Environmental Effects Report (AEE Report) on behalf of Orbital Express Launch Limited (‘the Applicant’) regarding their application to the Civil Aviation Authority (the regulator) for a licence under the Space Industry Act 2018.

1.1.2 The Applicant intends to launch Orbex PRIME Launch Vehicles on sub-orbital and orbital trajectories from Launch Pad 3 at the SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland and as such is applying to the UK Civil Aviation Authority (CAA) for a launch operator licence. The licence application will seek permission for up to 10 Orbex PRIME Launch Vehicle launches per year for 30 years; covering both sub-orbital and orbital launches.

1.1.3 For the purposes of this AEE Report the proposed launch operations will be referred to as ‘the Proposed Project’.

1.1.4 The location of the Proposed Project is shown on Drawing 3.1 in Volume III. The Proposed Project is summarised in Section 1.5 and described in full in Chapter 3.

1.2 The Applicant

1.2.1 The Applicant for the Proposed Project is Orbital Express Launch Limited (Orbex).

1.2.2 Orbex is a private launch services company developing a small commercial orbital rocket: the Orbex PRIME Launch Vehicle, a two-stage launch vehicle that will carry small satellites up to 180 kg to polar and sun synchronous orbits. Initially, sub-orbital trajectories are proposed as part of the ongoing development program and are therefore also covered by the AEE.

1.2.3 The Orbex PRIME Launch Vehicle is powered by seven engines that run on Liquified Petroleum Gas (LPG) with Liquid Oxygen (LOX) as the oxidiser.

1.2.4 Orbex is a company incorporated in England with its registered office at 1st Floor One Suffolk Way, Sevenoaks, Kent, England, TN13 1YL.

1.3 Background

1.3.1 As set out in the National Space Policy (UK Government 2018) and the later National Space Strategy (UK Government, 2021), the UK aims to become the European hub for commercial spaceflight and related sector technologies. The UK Government is committed to building one of the most innovative and attractive space economies in the world, supporting the growth of a robust and competitive commercial space sector growing the value of the UK Space Sector to £40 billion by 2030, representing approximately 10 % of the global market.

1.3.2 The Applicant’s primary goal is to support the space industry by providing access to space. In Orbex PRIME, the company has developed one of the most advanced, low carbon, high performance micro-launch vehicles in the world.

1.4 Regulatory Requirements and Guidance

Space Industry Act 2018

1.4.1 The Space Industry Act 2018 received Royal Assent on 15 March 2020 and provides a legal framework for the licensing of space activities, sub-orbital activities and associated activities carried out in the UK.

1.4.2 The Act requires that any person or organisation wishing to undertake the following to obtain a relevant licence:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities form the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

1.4.3 As the Applicant wishes to become a spaceflight operator and launch Orbex PRIME Launch Vehicles from the UK, it is required to apply for a launch operator licence, and as part of this application, submit an AEE of the Proposed Project.

Space Industry Regulations 2021

1.4.4 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence and the regulators licensing rules, which specify what information the CAA, the regulator, requires in support of an application.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

1.4.5 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note 'CAP2215 Guidance for the Assessment of Environmental Effects' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

1.4.6 The guidance describes the licence required by the Applicant as follows:

- *A launch operator licence means an operator licence within section 3 of the Act which authorises a person or organisation to carry out spaceflight activities… A person or organisation holding a launch operator licence is referred to as a spaceflight operator, or in some circumstances, launch operator licensee. If a launch operator licensee wishes to return a launch vehicle launched from the UK or the UK's territorial waters to land in the UK, it can apply to do so under the launch operator licence and does not need to apply for a separate return operator licence.*

1.4.7 AEE is relevant to applications for launch operator licences and so this document has been prepared in support of the launch operator licence application.

Guidance to the Regulator on Environmental Objectives relating to the Exercise of its Functions under the Space Industry Act 2018

1.4.8 The Department for Transport issued its document 'Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objectives for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*
- *Protect people and wildlife from the impacts of noise from spaceflight activities;*
- *Protect the marine environment from the impact of spaceflight activities.*

1.4.9 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE. Consideration of the environmental objectives has been included as relevant in the AEE technical assessment chapters.

1.5 The Proposed Project

1.5.1 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicles onto both sub-orbital and orbital trajectories, from Launch Pad 3 at the SaxaVord Spaceport Lamba Ness Launch Site (LNLS) situated on the Lamba Ness peninsula in Unst, Shetland.

1.5.2 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure. The fuel for both stages is LPG, with Liquid Oxygen (LOX) as the oxidiser. Helium (He) is utilised on both stages for pressuring the fuel and oxidiser tanks. Whilst the Orbex PRIME Launch vehicle is designed to be reusable, at the current stage of technology development, re-use / recovery processes are not planned until later flights and following technology testing and validation. As such for the purposes of this AEE the Orbex PRIME Launch Vehicle is considered to be expendable with no recovery planned.

1.5.3 The Orbex PRIME Launch Vehicle is designed to launch payloads of up to 180 kg into both sub-orbital trajectories and sun synchronous and polar orbits. The environmental zone of interest (EZI) for the Proposed Project is contained between 085 and 100 degrees from the equator. All launches will take place from Launch Pad 3 at SaxaVord Spaceport.

1.5.4 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year.

1.5.5 For the purposes of this AEE, orbital launches of the Orbex PRIME Launch Vehicle have been determined to be, and assessed as, the limiting case launch scenario. Commentary on the justification for this is provided in Chapter 2, with further information on the specification of Orbex PRIME sub-orbital launches included as Appendix 2.1. A full description of the Proposed Project and the Orbex PRIME Launch Vehicle and orbital launch specification are provided in Chapter 3 with a summary provided below for information.

1.5.6 The Proposed Project consists of the following, and where appropriate throughout, the term "Proposed Project" shall mean all of the following elements:

- Preparation of the Orbex PRIME Launch Vehicle;
- Storage and handling of Orbex PRIME Launch Vehicle propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of Orbex PRIME Launch Vehicle (including discarded component drop zones).

1.5.7 The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure at the LNLS:

- Launch Pad 3: the most easterly of the three launch pads located on the Lamba Ness peninsula; Launch Pad 3 incorporates ground services storage and control, lightning protection masts, liquid and compressed gas storage and water deluge tanks for launch operations;
- Satellite Tracking Station: an area of hardstanding housing satellite tracking and telemetry devices located on the Lamba Ness peninsula;
- Rocket Hall 2 of the Integration Hangar A: the building where the Orbex PRIME Launch Vehicles will be assembled and the payload(s) integrated;
- Administration Building and Hazardous Materials Store located on the LNLS;
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

1.5.8 A full description of the Proposed Project is provided in Chapter 3.

1.5.9 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first launch as soon as Q4 2025 and then increase cadence to 10 launches per year.

1.5.10 This AEE has been carried out assuming the maximum 10 launches of the Orbex PRIME Launch Vehicle per year as a worst case scenario.

1.6 Environmental Budget

1.6.1 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own environmental budget of 30 launches per year.

1.6.2 Whilst the Applicant has not yet determined a specific timeframe for launch operations, when required for the purposes of this AEE an operational phase of 30 years (equating to 300 launches) has been assumed, aligning with the current land lease for SaxaVord Spaceport. This applies in particular to the process of calculating the total mass of returning components, required for the Marine and Transboundary assessment (Chapter 10).

1.6.3 For other technical disciplines the appropriate timeframe for assessment varies – for example for ecology/ornithology the appropriate timeframe is considered generally to be a year due to breeding seasonality, and similarly cumulative noise effects are assessed over the period of a year. Whereas for air quality, due to the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within a 24-hour period) the appropriate assessment period is considered to be a single launch. Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

Launch Frequency

1.6.4 The Applicant's environmental budget is for a maximum of 10 launches per year. In terms of launch frequency, it is anticipated that there will be a maximum of two launches per month.

1.6.5 In line with SaxaVord Spaceport's commitment to a no-launch window between mid-May and the end of June in order to protect breeding birds, no launches of the Orbex PRIME Launch Vehicle will be carried out during this period.

1.7 Site Description

1.7.1 The Proposed Project will operate from the SaxaVord Spaceport LNLS in Unst, the most northerly of the Shetland Islands.

1.7.2 For the purposes of this AEE, the boundary of the Proposed Project has been assumed as the areas within SaxaVord Spaceport where the delivery, preparation and launch of the Orbex PRIME Launch Vehicle will take place. The Proposed Project site boundary is shown on Drawing 3.1 in Volume III, centred on national grid reference 466470 E, 121550 N and occupies an area of approximately 28 hectares. It is approximately 2.5 km north-east of the settlement of Norwick.

1.7.3 There are no residential properties located within the boundary of the Proposed Project or that of SaxaVord Spaceport, with the closest property, the Haa, located approximately 0.6 km away. The Haa is uninhabited and will remain so for the duration of operation of the Proposed Project as it is unfit for habitation. Accordingly, it has not been considered as a residential receptor and the closest residential receptors are therefore the properties in Norwick, located approximately 2.5 km south-west of the Proposed Project.

1.8 Designated Sites

1.8.1 A plan showing relevant designated sites within the vicinity of the Proposed Project is included as Volume III Drawing 1.1.

Ecological Designations

1.8.2 There are no statutorily designated sites relevant to ecology within the boundaries of the Proposed Project.

1.8.3 There are a number of national and international statutorily designated sites relevant to ecology in the vicinity of the Proposed Project, with 10 designated sites within 10 km as follows:

- Hermaness, Saxa Vord and Valla Field Special Protection Area (SPA) - Designated for breeding birds: fulmar (Fulmarus glacialis), gannet (Morus bassanus), great skua (Stercorarius skua), common guillemot (Uria aalge), kittiwake (Rissa tridactyla), puffin (Fratercula arctica), red-throated diver (Gavia stellata), shag (Phalacrocorax aristotelis) and breeding bird assemblages;
- Keen of Hamar Special Area of Conservation (SAC) - Designated for upland habitats: base rich scree, dry heath and grasslands on soils rich in heavy metals;
- Keen of Hamar Site of Special Scientific Interest (SSSI) - Designated for Calaminarian grassland and serpentine heath and vascular plant assemblages;
- Hill of Colvadale and Sobul SSSI - Designated for Arctic sandwort (Arenaria norvegica), breeding Arctic skua (Stercorarius parasiticus), whimbrel (Numenius phaeopus), calaminarian grassland and serpentine heath and breeding bird assemblages;
- Valla Field SSSI - Designated for breeding great skua and red-throated diver;
- Crussa Field and Heogs SSSI - Designated for breeding Arctic skua, whimbrel, vascular plant assemblages, Calaminarian grassland and serpentine heath and breeding bird assemblages;
- Hermaness SSSI - Designated for breeding gannet, great skua, guillemot, puffin and breeding seabird colony;
- Saxa Vord SSSI - Designated for breeding fulmar, guillemot and breeding seabird colony;
- Norwick Meadows SSSI - Designated for sand dune habitats and valley fen wetlands; and,
- Fetlar to Haroldswick Marine Protection Area - Designated for aggregation of breeding birds: black guillemot (Cepphus grylle), horse mussel beds, circalittoral sand and coarse sediment communities and kelp and seaweed communities on sublittoral sediment.

1.8.4 The Hermaness, Saxa Vord and Valla Field SPA lies approximately 1.5 km west of the Proposed Project along the northern Unst coastline. The SPA consists of 100 – 200 m high sea cliffs and adjoining areas of grassland, heath and blanket bog, and the seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface. The boundary of the SPA is coincident with that of the Saxa Vord SSSI and Hermaness SSSI which are located approximately 3 km and 4 km north-west of the Proposed Project respectively.

1.8.5 The high cliffs and stacks of the Hermaness SSSI support large colonies of nesting seabirds, with some species individually reaching numbers of national importance. Inland from the cliffs, the bog and heath vegetation provide nesting habitat for one of the largest colonies of great skua in the world, representing over 3% of the global population.

1.8.6 The Saxa Vord SSSI contains several skerries which, along with the sea cliffs, support a wide range of seabirds. This SSSI site is notified for its nationally and internationally important breeding fulmar and guillemot populations and for the seabird colony as a whole. The site supports a breeding colony of fulmar and guillemot contributing to 1.2% and 0.4% of the British population respectively.

1.9 Environmentally Sensitive Periods of Time

No-launch window

1.9.1 Following consultation with NatureScot during the planning application stage for the Spaceport, SaxaVord Spaceport committed to a no-launch window whereby no launches will be carried out between mid-May and the end of June so as to avoid disturbing birds during the critical incubation and early brooding period. The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.

Night-time Operations

1.9.2 Shetland has long hours of daylight in the summer months, but long hours of darkness in winter. In Shetland in winter at this latitude it can be dark from 3pm through to 9am.

1.9.3 However, for the purposes of this AEE night-time effects are relevant to the noise impact assessment and as such the night-time period has been assumed to be 23:00 – 07:00, as defined in Noise Guidance Document Planning Advice Note (PAN)1/2011 and Technical Advice Notes (TAN) and based on the period of time when the population is likely to be asleep or at rest.

1.9.4 Of the proposed 10 launches per year, when taking into account the no-launch window agreed between mid-May to the end of June, the Applicant anticipates that in any one month there will be a maximum of two launches of the Orbex PRIME Launch Vehicle. Given the proposed frequency of launches and the short duration of the associated noise events adverse effects associated with sleep disturbance due to night-time launches are considered to be minimal.

1.10 Purpose of Assessment of Environmental Effects (AEE)

1.10.1 The AEE process is the systematic process of identifying, predicting and evaluating the environmental effects of a proposed project. This AEE Report sets out the conclusions of the AEE process undertaken in relation to the Proposed Project. Where appropriate, it also sets out mitigation measures designed to prevent, reduce and, if at all possible, offset significant effects. An assessment of residual effects, those expected to remain following implementation of mitigation measures, is also presented.

1.10.2 The main findings and conclusions of the AEE Report are summarised in a Non-Technical Summary (NTS) presented in Volume I.

1.11 AEE Project Team

1.11.1 In preparing the AEE, reference has been made to the AEE for PRIME launches from the Sutherland Spaceport, prepared by Atlantic58 and its associated team.

1.11.2 This AEE has been undertaken by Aurora, supported by external consultants as shown in Table 1.1. CVs for the AEE team are included in Appendix 1.1.

Table 1.1 – AEE Team

Discipline	Lead Specialist	Qualifications	Accreditations	Professional Experience (years)
AEE management and review, authoring of introductory and concluding chapters	Ruth Fain, Aurora	MGeol. (Hons) Environmental Geology	Chartered Scientist (CSci) Member of the Institution of Environmental Sciences (MIEnvSc) NEBOSH General Certificate	20+
Climate Change Accidents	Gavin Bollan, SLR	BSc (Hons) Environmental Science	Member of the Institution of Environmental Sciences, Fellow of the Institute of Air Quality Management, Chartered Scientist, Chartered Environmentalist	25+
Ornithology	Dr Peter Cosgrove, Alba Ecology	PhD Ornithology	FCIEEM	25+
Ecology	Dr Kate Massey, Alba Ecology	PhD Ecology	MCIEEM	15+
Air Quality	Annie Danskin, SLR	BEng (Hons) Environmental Engineering	Chartered Environmentalist (CEnv) Member of the Institution of Environmental Sciences (MIEnvSc)	25+
Noise and Vibration	Michael James, Blue Ridge Research and Consulting LLC	B.S., Mechanical Engineering, Virginia Tech M.S, Mechanical Engineering, Virginia Tech	BRRC founding member and principal. >50 military, civilian aviation, rockets, weaponry and blast noise studies incl NASA and SpaceX	20+
	Simon Waddell, SLR	BSc (Hons) Environmental Geoscience, University of Edinburgh Post-graduate Diploma Acoustics and Noise Control, Institute of Acoustics	Member Institute of Acoustics (MIOA)	10+

Discipline	Lead Specialist	Qualifications	Accreditations	Professional Experience (years)
Marine Effects / Transboundary Considerations	Dr Liam Dickson, ERM	PhD Marine Biology	Member of the British Ecological Society	5+
	Ian Reach, ERM	BSc. (Hons) Marine Biology with Fish Biology	Professional Member of the Marine Biological Association UK	25+
Landscape, Seascape and Visual Impact	Peter Dunmow, Hepla	BA (Hons) Landscape Architecture Dip LA, Landscape Architecture MA (Hons) Landscape Architecture	Chartered Member of the Landscape Institute	30+
Information and text contained within the PRIME-Sutherland Spaceport AEE.	Laura Carse, Atlantic58	BSc (Hons) Tropical Environmental Science MSc Marine Resource Development and Protection	Chartered Environmentalist (CEnv) Member of the Institute of Environmental Management and Assessment (MIEMA)	20+

1.12 Availability of the AEE Report

1.12.1 The CAA will undertake a formal public consultation process on this AEE. The CAA will provide the opportunity for representations to be made on the Proposed Project via the CAA consultation hub: https://consultations.caa.co.uk/. All representations will be taken into account before the CAA makes a decision on the application. Any representations on this AEE Report or other elements of the associated licence application should be made directly to the CAA.

1.13 References

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CHAPTER 2 Approach to AEE

2. Approach to AEE

2. Approach to AEE

2.1 Introduction

2.1.1 This AEE Report comprises a Non-Technical Summary (NTS), the main AEE Report text, accompanying drawings and technical appendices.

2.1.2 This chapter of the AEE describes the overarching legislative and policy context in relation to the Proposed Project and sets out the overarching approach to assessment of environmental effects. Sector or technical discipline-specific methodologies are further detailed in the technical chapters. In addition to the broad legislative context, consideration has also been given to the compliance of the AEE with broad 'Environmental Objectives' published by the Department for Transport (DfT, 2021).

2.2 Limiting Case Launch Scenario

2.2.1 The Proposed Project comprises the preparation and launch along both sub-orbital and orbital trajectories of the Orbex PRIME Launch Vehicle from Launch Pad 3 at the SaxaVord Spaceport Lamba Ness Launch Site (LNLS) situated on the Lamba Ness peninsula in Unst, Shetland. As such the Proposed Project is regulated under the Space Industry Act 2018 ('the Act').

2.2.2 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure. The fuel for both stages is Liquid Petroleum gas (LPG), with Liquid Oxygen (LOX) as the oxidiser. Helium (He) is utilised on both stages for pressuring the fuel and oxidiser tanks. Whilst the Orbex PRIME Launch vehicle is designed to be reusable, at the current stage of technology development, re-use / recovery processes are not planned until later flights and following technology testing and validation. As such for the purposes of this AEE the Orbex PRIME Launch Vehicle is considered to be expendable with no recovery planned.

2.2.3 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year.

2.2.4 The Orbex PRIME Launch Vehicle is designed to launch payloads of up to 180 kg into both sub-orbital and orbital trajectories.

2.2.5 The composition and dimensions of the Orbex PRIME Launch vehicle remain consistent across both sub-orbital and orbital campaigns. However, during sub-orbital missions, the fuel required to propel the Orbex PRIME Launch Vehicle is less than that required for orbital campaigns. Also, during sub-orbital campaigns the drop zone for returning components from the first stage, interstage, second stage and fairings will all be in the North Atlantic (one zone); whereas for orbital campaigns the drop zone for the first stage, interstage and fairings is in the North Atlantic, but the returning second stage is anticipated to fall within a drop zone in the Pacific.

2.2.6 A comparison of the two launch scenarios is included as Appendix 2.1. The fuelling specifics and returning components of the two launch scenarios has been assessed by all technical leads working on the AEE and it has been confirmed that for all topics, the orbital launches will result in greater effects across all potential impact pathways.

2.2.7 As such, for the purposes of this AEE, orbital launches of the Orbex PRIME Launch Vehicle have been assessed as the worst case launch scenario and as such represent the limiting case for Orbex PRIME launches from the SaxaVord Spaceport.

2.3 Legislation, Policy and Guidance

2.3.1 The Proposed Project consists of the following, and where appropriate throughout, the term “Proposed Project” shall mean all of the following elements:

- Preparation of the Orbex PRIME Launch Vehicle;
- Storage and handling of Orbex PRIME Launch Vehicle propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of Orbex PRIME Launch Vehicle (including drop zones).

2.3.2 Section 11 of the Act stipulates that all Applicants for a launch operator licence are required to submit an assessment of environmental effects (AEE) as part of their licence application. The regulator, the Civil Aviation Authority (CAA), is required to take the AEE into account when deciding whether to grant a licence and what, if any, conditions should be attached to such a licence, and cannot grant a launch operator licence until the AEE has been submitted.

2.3.3 Under section 11(4) of the Act the regulator can permit Applicants to submit an equivalent assessment, prepared previously, as part of the AEE.

2.3.4 Whilst this AEE Report is issued as a standalone AEE submission and all effects have been assessed in terms of the Proposed Project, the assessment does refer to, and as relevant include as appendices, previous relevant assessments and documents submitted either to Shetland Islands Council as part of the planning application for the SaxaVord Spaceport (reference 2021/005/PPF) or to the CAA as part of the subsequent SaxaVord Spaceport operator licence application (reference SR-APP-001019) where operational phase elements of the reports relate directly to the AEE and it was considered disproportionate to duplicate these assessments as stand-alone AEE only assessments.

2.3.5 Reference has also been made to the Sutherland Spaceport licence application (reference SR-APP-001254). However, as assessment of effects on the environment is primarily related to geographic location, none of the studies undertaken for the Sutherland Spaceport are utilised in this AEE.

2.3.6 Documents included in their original format (i.e., that which has already gone through the planning process and been considered by Shetland Islands Council or to the CAA as part of the subsequent SaxaVord Spaceport operator licence application and can therefore be considered ‘equivalent assessments’) include:

- Appendix 5.1 (a) Shetland Space Centre Breeding Bird Survey, 2020. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Included in SaxaVord Spaceport AEE and submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 5.2 - Background Literature Review. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment.
- Appendix 5.3 - Detailed Habitat Management Plan, February 2022 – document produced subsequent to receipt of planning consent as part of pre-commencement conditions. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Included in SaxaVord Spaceport AEE as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 6.1 – Natural Heritage Desk Study. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment.
- Appendix 6.2 – Phase 1 Habitat, National Vegetation Classification (NVC) and Groundwater Dependent Terrestrial Ecosystem (GWDTE) Survey Report. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment.
- Appendix 6.3a Otter Survey Report and Species Protection Plan, March 2022 - document produced subsequent to receipt of planning consent as part of pre-commencement conditions. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Included in SaxaVord Spaceport AEE as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 6.3b Pre-construction Otter Survey Report, March 2022 - document produced subsequent to receipt of planning consent as part of pre-commencement conditions. The document has been reviewed by Shetland Islands Council and relevant statutory consultees. Included in SaxaVord Spaceport AEE as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 6.4 – Freshwater Pearl Mussel Survey Report. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment.
- Appendix 6.5 – SaxaVord AEE Chapter 9 Water. Included in SaxaVord Spaceport AEE as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 8.1 – BRRC Noise Study - Included in SaxaVord Spaceport AEE as submitted previously to the CAA. Document unchanged since then – equivalent assessment.

- Appendix 8.2 – Summary of Guidance - Included in SaxaVord Spaceport AEE as submitted previously to the CAA. Document unchanged since then – equivalent assessment.
- Appendix 8.3 – Noise Baseline Survey. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment.
- Appendix 8.4 – Noise Traffic Flow Data. Submitted to Shetland Islands Council with the planning application. Document unchanged since then – equivalent assessment.

2.3.7 The following appendices have been updated during the Orbex PRIME SaxaVord AEE process:

- Appendix 1.1 – CVs. Updated from those included in SaxaVord Spaceport AEE submitted previously to the CAA.
- Appendix 2.1 Sub-orbital – Orbital Launch Comparison – document produced specifically for Orbex PRIME SaxaVord AEE.
- Appendix 2.2 LVIA Scoping Opinion Letter – document produced subsequent to receipt of planning consent as part of pre-application consultation with CAA for previous Launch Operators. Document reviewed and updated to reflect Orbex PRIME following Landscape and Visual Impact Assessment (LVIA) having been discussed and scoped out of the AEE during the CAA pre-application meeting 13 December 2024.
- Appendix 2.4 Population and Human Health Precis – document produced subsequent to receipt of planning consent as part of pre-application consultation with CAA for previous Launch Operators. Document reviewed and updated to reflect Orbex PRIME after population effects discussed and scoped out of the AEE during the CAA pre-application meeting 13 December 2024.
- Appendix 4.1 Greenhouse Gases (GHG) Calculations – document based on the calculation's method included in the SaxaVord Spaceport AEE but updated to reflect Orbex PRIME emissions.
- Appendix 5.1 (b) Shetland Space Centre Breeding Bird Survey 2022 – the Breeding Bird Survey for the LNLS has been updated prior to preparation of this AEE. Whilst not specific to Orbex PRIME operations; this update should be noted by the regulator.
- Appendix 5.1 (c) Shetland Space Centre Breeding Bird Survey 2023 – the Breeding Bird Survey for the LNLS has been updated prior to preparation of this AEE. Whilst not specific to Orbex PRIME operations; this update should be noted by the regulator.
- Appendix 5.1 (d) Shetland Space Centre Breeding Bird Survey 2024 – the Breeding Bird Survey for the LNLS has been updated prior to preparation of this AEE. Whilst not specific to Orbex PRIME operations; this update should be noted by the regulator.

- Appendix 6.3c SaxaVord Spaceport Otter Survey Report and Species Protection Plan, December 2024 - the Otter Survey and Species Protection Plan for the LNLS has been updated prior to preparation of this AEE as part of ongoing planning condition commitments.
- Appendix 7.1 Launch Emissions Assessment – document based on the calculation method included in the SaxaVord Spaceport AEE but updated to reflect Orbex PRIME emissions.
- Appendix 10.1 – document based on the planning policy screening included in the SaxaVord Spaceport AEE but updated to reflect changes during the Orbex PRIME preparation period.
- Appendix 10.2 – document based on the baseline screening assessment included in the SaxaVord Spaceport AEE but updated to reflect Orbex PRIME EZI.
- Appendices 10.3, 10.4 and 10.5 Risk matrices – documents based on the risk assessment included in the SaxaVord Spaceport AEE but updated to reflect Orbex PRIME operations.
- Appendix 10.6 – list of marine receptors specific to the Orbex PRIME AEE.

2.3.8 Other than changes specific to the Orbex PRIME Launch Vehicle, which are detailed in full in this AEE (with relevant changes made to appended documents as listed in 2.3.7 above), there have been no materially significant changes to the design of SaxaVord Spaceport or the operational activities between submission of SaxaVord Spaceport planning application/AEE and preparation and submission of this associated Launch Operator AEE and therefore the original appendix documents listed in 2.3.6 are considered valid for the purposes of this AEE.

2.3.9 There are no regulations for the AEE, however, under section 11(6) of the Act, the regulator is required to issue guidance. The AEE therefore follows the requirements set out in 'CAP2215 Guidance for the Assessment of Environmental Effects' (CAA et. al. 2021). As applicable, reference is also made to guidance document CAP1616: Airspace change: Guidance on the regulatory process for changing the notified airspace design and planned and permanent redistribution of air traffic, and on providing airspace information (CAA, 2021).

2.3.10 In addition to the CAA guidance, in undertaking the AEE, the established framework for conducting environmental impact assessments, required by the Town and Country Planning (Environmental Impact Assessment) Regulations 2017 and Marine Works (Environmental Impact Assessment) Regulations 2017 have been considered. Within that framework, consideration has been given to the following:

- Guidelines for Environmental Impact Assessment, Institute of Environmental Management and Assessment (IEMA, 2006);
- A Handbook on Environmental Impact Assessment Version 5 (Scottish Natural Heritage, 2018); and
- Shetland Outdoor Access Strategy (Shetland Islands Council, 2019).

2.4 The AEE Process

2.4.1 The purpose of AEE is 'to ensure that the Applicants for launch operator licences have considered the potential environmental effects of their intended activities and, if necessary, taken appropriate and proportional steps to avoid, mitigate or offset the risks and their potential effects' (CAA et. al. 2021).

2.4.2 AEE is the systematic process of identifying, quantifying, and evaluating the potential effects of the proposed activities on the environment. The key stages in the AEE process are presented in this chapter, with an overview of the specific methodology adopted for each technical study provided within the respective technical chapters (Chapters 4 to 10).

2.4.3 As stated in the CAA guidance document, the process of AEE can be broken down into four main phases as shown in Figure 2.1.

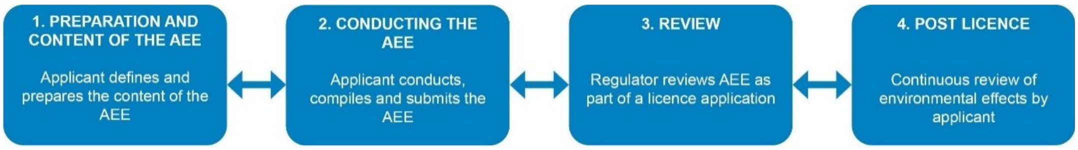

Figure 2.1 Overview of the AEE Process

2.5 Scope of the AEE

Environmental Zone of Influence

2.5.1 The environmental zone of influence (EZI) of the AEE, in other words the spatial scope or geographical coverage of the assessment, takes into account of a number of factors, in particular:

- the extent of the Proposed Project (refer to Drawings 3.1 and 3.2);
- the nature of the baseline environment, sensitive receptors and the likely impacts that may arise; and,
- the distance over which predicted effects are likely to remain significant and, particularly, the existence of pathways which may result in the transfer of effects to a wider geographical area than the extent of proposed physical works.

2.5.2 For the purposes of this AEE, the EZI is based on and comprises the proposed launch flight corridors (which extend in a northerly direction over the sea along azimuths of 085 - 100 degrees from the equator) and all study areas required for the technical disciplines included in the AEE.

2.5.3 The North Atlantic EZI (incorporating drop zones for the first stage, interstage and fairings) is indicated on Figure 3.1 in Chapter 3 and presented in more detail on Drawings 10.1 and 10.2. The Pacific EZI (incorporating drop zone for the returning second stage) is indicated on Figure 3.2 in Chapter 3 and presented in more detail on Drawing 10.6.

2.5.4 Within the EZIs, the study area(s) required for each technical discipline assessed vary and as such the rationale for each study area has been included in relevant technical chapter. Individual study areas are shown in detail on Drawing 2.1.

Temporal Scope

2.5.5 The baseline year used for the assessment of effects has been taken as 2024, with the assumption that SaxaVord Spaceport is fully constructed and operational. However, appropriate technical disciplines have carried out pre-assessment studies and/or literature reviews from wider timeframes, for example, ecology and ornithology surveys have been undertaken from 2018 - 2024 and the Climate, Heritage and Marine and Transboundary Effect chapters refer to datasets spanning the period 1970 - 2020 as relevant.

Environmental Budget

2.5.6 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own environmental budget of 30 launches per year.

2.5.7 Whilst the Applicant has not yet determined a specific timeframe for operations, when required for the purposes of this AEE an operational phase of 30 years (equating to 300 launches) has been assumed, aligning with the current land lease for SaxaVord Spaceport. This applies in particular to the process of calculating total mass of returning components, required for the Marine and Transboundary assessment (Chapter 10).

2.5.8 For other technical disciplines the appropriate timeframe for assessment varies – for example for ecology/ornithology the appropriate timeframe is considered generally to be a year due to breeding seasonality, and similarly cumulative noise effects are assessed over the period of a year. Whereas for air quality, due to the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within a 24 hour period) the appropriate assessment period is considered to be a single launch. Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

2.6 AEE Preparation and Content

Content

2.6.1 This AEE looks to identify, describe, and assess the potential direct and indirect significant effects of the Proposed Project.

2.6.2 A launch operator AEE is described in section 11(3)(b) of the Act:

'Assessment of environmental effects... In relation to an operator licence authorising launch of spacecraft, means an assessment that those launches are expected to have on the environment.'

2.6.3 As required by the CAA guidance, this launch operator AEE covers all operations and activities intended to be carried out that may have an environmental effect. Effects on the following environmental features have been considered:

- Population and human health;
- Biodiversity (ecology and ornithology);
- Air quality;
- Noise and vibration;
- Water;
- Climate;
- Marine environment;
- Land, Soils and Peat;
- Landscape, Seascape and Visual Impact;
- Material assets and cultural heritage; and
- Accidents and Disasters.

2.6.4 Of these, due to the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the Orbex PRIME Launch Vehicle will not have significant effect on land condition due to the SaxaVord Spaceport infrastructure already in place, it is considered that the Proposed Project has no potential for significant effects on either the water environment or the condition of underlying land, soils or peat. As such, these elements have not been considered further within this AEE.

2.6.5 As the specification of the Orbex PRIME Launch Vehicle is within the limiting case envelope assessed for SaxaVord Spaceport (i.e., launches of sub-orbital sounding rockets and small satellites into either polar or sun-synchronous, low-earth orbits by multiple launch service providers using a range of different Launch Vehicle types up to 30 m in height), it is considered that no further assessment of visual impact is required on top of that previously submitted in the SaxaVord spaceport operator licence application AEE (reference SR-APP-001019). As such, landscape and visual assessment has not been considered further within this AEE. A note detailing the reasoning for this position is included as Appendix 2.2. The SaxaVord Spaceport LVIA Chapter has been included for reference as Appendix 2.3.

2.6.6 Similarly, it is considered that assessment of population effects is not required as the Proposed Project is within the limiting case envelope assessed for SaxaVord Spaceport - sub-orbital and orbital launches of small satellites into either polar or sun-synchronous, low-earth orbits. As such the assessment of population effects completed for the SaxaVord Spaceport AEE is considered appropriate to this AEE.

2.6.7 A precis of the SaxaVord Spaceport population effects chapter, updated to reflect how the Proposed Project sits within the wider SaxaVord Spaceport assessment, is included as Appendix 2.4. The SaxaVord Spaceport AEE Population and Human Health Chapter has been included for reference as Appendix 2.5. Whilst relevant effects on Human Health from the Proposed Project are discussed in detail in the relevant technical chapters of the AEE Report; population effects have otherwise not been considered further in this AEE.

2.6.8 Due to the small number of launches proposed by the Applicant (maximum 10 per year), the temporary nature of each proposed launch and the fact that the delivery, assembly and launch of the Orbex PRIME Launch Vehicle will not have significant effect on material assets and cultural heritage due to the SaxaVord Spaceport infrastructure already in place, it is considered that the Proposed Project in isolation has no potential for significant effects on material assets and cultural heritage. As such, these elements have not been considered further in this AEE.

2.6.9 The likely significant cultural heritage effects of overall operation of SaxaVord Spaceport (and within that, therefore, operation of the Proposed Project) are inherently associated with the land-take and infrastructure required for the construction of the Spaceport and were carried over into the SaxaVord Spaceport AEE for assessment only by nature of the continued operation of the Spaceport infrastructure. Cultural heritage effects of the Spaceport overall have been assessed by Shetland Islands Council and the relevant statutory consultees (including HES, NatureScot and SEPA) during the planning stage of SaxaVord Spaceport and the Spaceport (and, by extension, associated future operations of Launch Operators) found to be suitable for development. Heritage plans and mitigation measures outlined within the Environmental Statement submitted with the Spaceport planning application have been included in the planning consent for SaxaVord Spaceport as conditions and accepted as being appropriate from a planning perspective. No further assessment for the purposes of this AEE is required.

2.6.10 It is acknowledged that in relation to the wider spaceflight activities / environmental budget of SaxaVord Spaceport, the SaxaVord Spaceport AEE includes a commitment to monitoring vibration during the operational phase; however, this is the responsibility of the Spaceport Operator, not of the Applicant or any other individual Launch Operator. Information on the monitoring program for the Spaceport is detailed in Chapter 14 of the SaxaVord Spaceport AEE, included for reference as Appendix 2.6. Orbex is committed to complying with any related monitoring required by SaxaVord Spaceport.

2.6.11 A detailed programme for the conservation management and monitoring of cultural heritage assets in the vicinity of SaxaVord Spaceport has been supplied to Historic Environment Scotland and to Shetland Islands Council to meet mitigation requirements of Scheduled Monument Consent and planning permission for SaxaVord Spaceport respectively. This conservation management plan, which is the responsibility of SaxaVord Spaceport, sets out a programme for ongoing condition monitoring of heritage assets over the operational lifespan of the spaceport, in consultation with Historic Environments Scotland and Shetland Islands Council.

Consultation

2.6.12 Although there is no statutory requirement for the Applicant to undertake scoping, pre-application consultation with the CAA has been undertaken, with the scope of this AEE as outlined above discussed with the CAA on 13 December 2024.

2.6.13 Some of the consultation with statutory and non-statutory consultees in regard to operation of SaxaVord Spaceport during the planning application phase for that development is considered relevant to this AEE and therefore, as applicable, details of consultation responses have been included in the technical chapters, alongside comments on subsequent additional post-planning consultations and any pertinent planning conditions arising from the SaxaVord Spaceport planning consent.

2.6.14 No further consultation has been undertaken during preparation of this AEE.

Conducting the AEE

2.6.15 The Applicant has engaged competent experts, as detailed in Chapter 1, to conduct the AEE.

2.6.16 The main steps in each of the technical impact assessments for the Proposed Project are as follows:

- Baseline surveys (where appropriate) to provide information on the existing baseline condition of the LNLS and surrounding area.
- Consideration of the possible interactions between the Proposed Project and the existing and predicted future site conditions. These interactions or effects are assessed using stated criteria based on accepted guidance and best practice.
- Using robust design parameters for the Proposed Project, assessment of the likely significant effects, including direct effects and any indirect, secondary, short, medium, and long-term, permanent and temporary, beneficial and adverse effects.
- Identification of any uncertainties inherent in the methods used, the predictions made, and the conclusions drawn during the assessment process.
- Identification of mitigation measures designed to avoid, reduce or offset any significant adverse effects identified as well as enhancement measures that may result in beneficial effects.
- Assessment of the significance of any residual effects after mitigation, in relation to the sensitivity of the feature impacted upon and the magnitude of the effect predicted, in line with the relevant methodology.
- Reporting of the results of the AEE in this AEE Report.

Assessing Significance

2.6.17 Throughout the assessment, a distinction has been made between the term 'impact' and 'effect'. The Act refers to the requirement to report the significance of "effects". An impact is defined as the likely change to the characteristics/nature of the receiving environment as a result of the Proposed Project (e.g., noise from a launch), whereas the 'effect' relates to the significance of the impact (e.g., a significant residual noise effect on residential properties). These terms have been adopted throughout this AEE Report to present a consistent approach to the assessment and evaluation of effects and their significance.

2.6.18 To determine whether the potential effects of the Proposed Project are likely to be ‘significant’ a number of criteria are used. Criteria can vary between topics but generally include:

- international, national, and local designations or standards;
- relationship with planning policy and guidance;
- sensitivity of the receiving environment;

- magnitude of impact;
- reversibility and duration of the effect; and,
- inter-relationship between effects.

2.6.19 Effects that are considered to be significant prior to mitigation but following the implementation of best practice are identified within this AEE Report. The significance attributed to the resultant effect is informed by an exercise of professional judgement in relation to the sensitivity of the affected receptor(s) and the nature, duration, frequency, and magnitude of the predicted changes/impacts. For example, a major adverse change/impact on a feature or site of low importance will have an effect of lesser significance than the same impact on a feature or site of high importance.

2.6.20 Table 2.1 is used as a guide to the relationship between the sensitivity of the identified receptor and the anticipated magnitude of an impact/change. Professional judgement is however equally important in establishing the suitability of this guiding 'formula' to the assessment of the significance of each individual effect.

Table 2.1 – Inter-Relationship between Magnitude of Impact and Sensitivity of Receptor

		Sensitivity of Receptor / Receiving Environment to change			
		High	**Medium**	**Low**	**Negligible**
Magnitude of Impact / change	**High**	major	moderate to major	minor to moderate	minor to negligible
	Medium	moderate to major	moderate	minor	negligible
	Low	minor to moderate	minor	negligible to minor	negligible
	Negligible	minor to negligible	negligible	negligible	negligible

2.6.21 The following terms are used in this AEE Report, unless otherwise stated, to determine the level of effects predicted to occur:

- significant beneficial or adverse effect – where the Proposed Project will result in a significant improvement (or deterioration) to the existing environment;
- moderate beneficial or adverse effect – where the Proposed Project will result in a noticeable improvement (or deterioration) to the existing environment;
- minor beneficial or adverse effect – where the Proposed Project will result in a small improvement (or deterioration) to the existing environment; and,
- negligible effect – where the Proposed Project will result in no discernible improvement (or deterioration) to the existing environment.

2.6.22 Using professional judgement and with reference to the Guidelines for Environmental Impact Assessment (IEMA, 2006), the majority of the assessments within this AEE Report consider effect levels of moderate or major to result in significant effects, and effect levels of minor or negligible to be non-significant. If there are deviations from this, these are clearly stated within the individual technical chapters.

2.6.23 Summary tables that outline the predicted pre-mitigation effects associated with an environmental issue, the mitigation measures proposed to address those, and the subsequent residual effect significance are provided in Chapter 11.

Assessing Cumulative Effects

2.6.24 Cumulative effects can be either inter-project or intra-project effects.

2.6.25 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together.

2.6.26 Due to the location of SaxaVord Spaceport, where the Proposed Project will operate from, on the north coast of Unst, the most northerly of the Shetland Islands; for all but one of the technical disciplines assessed there are no potential inter-project cumulative effects other than those from other SaxaVord Spaceport based launch operators as there are no other existing or proposed developments in the relevant EZIs. The exception to this is the marine and transboundary assessment (Chapter 10) wherein the EZI extends across a large area and therefore the Proposed Project has the potential to interact with offshore wind, marine renewables, oil and gas and subsea cable developments.

2.6.27 The potential for inter-project cumulative effects from separate launch service providers within the envelope of SaxaVord Spaceport operations and its associated environmental budget is considered at length in the SaxaVord Spaceport AEE submitted to the Civil Aviation Authority (CAA) in 2022 (reference SR-APP-001019); the conclusion of which is *'that there are no significant operational effects of concern from the [SaxaVord Spaceport] Proposed Project [i.e., launching of sub-orbital, sounding rockets and small satellites into either polar or sun-synchronous, low-earth orbits... by multiple launch service providers using a range of different launch vehicle types... up to 30 m in height] and that the proposed activities will comply with statutory requirements and environmental policy objectives.'*

2.6.28 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together.

2.6.29 Given that between environmental topics there is little overlap (for example, simultaneously occurring air quality and noise effects on a receptor have no combined cumulative effect) and because only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within 24 hour period), for all but three of the technical disciplines assessed there are no potential intra-project cumulative effects. The exceptions to this are:

- the ornithology and ecology assessments (Chapters 5 and 6) wherein effects on birds and wildlife of noise impacts associated with satellite launches (Chapter 8) have been assessed; and
- the marine and transboundary assessment (Chapter 10) wherein the potential additive effects of returning components from multiple launches of the Orbex PRIME Launch Vehicle have been assessed through time.

2.6.30 Within this AEE Report, therefore, cumulative effects for each technical discipline are covered as required on a chapter by chapter basis.

Assessing Mitigation Measures

2.6.31 The AEE presents a description of the measures proposed to avoid, reduce and, if possible, offset significant adverse effects. Wherever reasonably practicable, mitigation measures have been proposed for each significant environmental effect predicted, taking various forms including:

- changes to Proposed Project design;
- physical measures applied; and,
- measures to control particular aspects of the operation of the Proposed Project.

2.6.32 Where none of the above have been deemed practicable, the Proposed Project design includes measures to offset any significant adverse effects.

2.6.33 Monitoring measures may also be proposed, where appropriate, to examine the mitigation measures to ensure that they have the desired outcomes.

2.6.34 Mitigation measures and monitoring requirements are committed to in order to ensure a level of certainty as to the environmental effects of the Proposed Project. For the avoidance of any doubt, the Applicant is committed to implementing all mitigation measures and monitoring requirements identified in this AEE Report.

Review of the AEE

2.6.35 Following submission of the AEE, the regulator will review the document to satisfy itself that the Applicant's assessment is sufficiently robust and provides adequate protection of the environment.

2.6.36 As part of the review, the regulator will take into account comments received from the public or other organisations throughout the consultation process. The regulator can then:

- Determine that the environmental effects as set out in the AEE are acceptable and continue with its assessment of the licence application;
- Request that the Applicant revisits some areas of the AEE and then resubmit it;
- Determine whether to impose licence conditions.

Post Licence

2.6.37 The licensee will be responsible for required monitoring of environmental effects across the EZI throughout operation of the Proposed Project.

2.7 Assumptions, Limitation and Uncertainty

2.7.1 The AEE process is designed to enable informed decision-making based on the best available information about the environmental implications of a Proposed Project. However, it is acknowledged there will always be some uncertainty inherent in the scale and nature of the predicted environmental effects as a result of the level of detailed information available at the time of assessment, the potential for minor alterations to the Proposed Project following completion of the AEE Report and/or the limitations of the prediction processes.

2.7.2 Several assumptions have been made during the AEE process and are described below:

- The principal land uses adjacent to the Proposed Project will remain unchanged during the Proposed Project's lifetime.
- Information provided by third parties, including publicly available information and databases, is correct at the time of submission.

2.7.3 Specific assumptions may also be made with regard to the individual technical disciplines. As applicable, these are detailed within each chapter.

2.7.4 Any limitations to the AEE are summarised in each technical chapter, where relevant, together with the methods proposed and undertaken to mitigate these.

2.8 AEE Report

2.8.1 This AEE Report is comprised of four volumes:

- Volume I – Non-Technical Summary;
- Volume II – Main AEE Report;
- Volume III – Drawings; and
- Volume IV – Technical Appendices.

2.8.2 In addition, confidential elements of the AEE assessment have been provided to the CAA separately in Volume V – Confidential Appendix.

2.8.3 As suggested in the guidance document (CAA et.al. 2021), the AEE Report includes:

- a non-technical summary (AEE Report Volume I);
- an introduction (AEE Report Volume II, Chapter 1);
- the scope of the assessment (AEE Report Volume II, Chapter 2);
- a description of the Proposed Project (AEE Report Volume II, Chapter 3);
- a description of the environmental baseline conditions, EZI, assessment methodology and conclusions on likely significant effects, including cumulative effects, of the Proposed Project on the environment (AEE Report Volume II, Chapters 4 to 10); and

- a description of the features of the Proposed Project and any measures envisaged to avoid, prevent, or reduce and, if possible, offset likely significant adverse effects (AEE Report Volume II, Chapters 4 to 10 and summarised in Chapter 11).

2.8.4 References are included within each Chapter in Volume II.

2.8.5 Volume III contains the associated drawings that inform the AEE Report.

2.8.6 Volume IV contains relevant supporting reports and information for each of the technical disciplines prepared to inform the AEE chapters in Volume II of the AEE Report.

2.9 References

Civil Aviation Authority et. al. (2021) *CAP2215 Guidance for the Assessment of Environmental Effects*. Available at

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Chapter 3 Description of Proposed Project

3. Proposed Project

3. Proposed Project

3.1 Introduction

3.1.1 The Space Industry Act 2018 requires any organisation wishing to operate as a launch operator in the UK to obtain a relevant licence.

3.1.2 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicle from Launch Pad 3 at SaxaVord Spaceport Lamba Ness Launch Site (LNLS) situated on the Lamba Ness peninsula in Unst, Shetland. The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year, and as such is applying to the UK Civil Aviation Authority (CAA) for a launch operator licence as required by the Space Industry Act 2018.

3.1.3 Section 11 of the Act stipulates that all Applicants for a launch operator licence are required to submit an assessment of environmental effects (AEE) as part of their licence application. The CAA is required to take the AEE into account when deciding whether to grant a licence and what, if any, conditions should be attached to such a licence.

3.2 Background

3.2.1 The Applicant's primary goal is to support the space industry by providing access to space. In Orbex PRIME, the company has developed one of the most advanced, low carbon, high performance micro-launch vehicles in the world.

3.2.2 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure and designed to launch payloads of up to 180 kg into both sub-orbital and orbital trajectories.

3.2.3 The Environmental Zone of Interest (EZI) for the Proposed Project is contained between 085 and 100 degrees from the equator. All launches will take place from Launch Pad 3 at SaxaVord Spaceport.

3.2.4 All launches will take place in a northerly direction over the sea. For safety reasons, the Orbex PRIME Launch Vehicles will not fly over inhabited areas. Jan Mayen, located north north-west of Shetland and which is temporarily inhabited during the summer months, will also be a flight exclusion zone. The Applicant is committed to constraining launch trajectories in order to avoid jettisoned separated components impacting inhabited land masses, or waters within 12 miles of those coastlines, in compliance with international treaties.

3.2.5 Sub-orbital launches of the Orbex PRIME Launch Vehicle will take place along a 089.5° azimuth from Launch Pad 3 and will only be allowed to occur when meteorological conditions are such that no southerly movement of the Orbex PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences.

3.4 Proposed Project Location

3.4.1 The Proposed Project will operate at SaxaVord Spaceport LNLS in Unst, the most northerly of the Shetland Islands.

3.4.2 For the purposes of this AEE, the boundary of the Proposed Project has been assumed as the areas within SaxaVord Spaceport where the delivery, preparation and launch of the Orbex PRIME Launch Vehicle will take place. The Proposed Project boundary is shown on Drawing 3.1 in Volume III, centred on national grid reference 466470 E, 121550 N and occupies an area of approximately 28 hectares. It is approximately 2.5 km north-east of the settlement of Norwick.

3.5 SaxaVord Spaceport Infrastructure

3.5.1 The infrastructure required for the Proposed Project is being provided by SaxaVord Spaceport, which is subject to regulation under the Act itself and has completed an AEE as part of its own Spaceport Operator Licence application (document reference LP-004-SAXA, application SR-APP-001019). The Proposed Project layout plan shows the infrastructure of SaxaVord Spaceport and is included as Drawing 3.2 in Volume III.

3.5.2 The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure at the LNLS:

- Launch Pad 3: the most easterly of the three launch pads located on the Lamba Ness peninsula. Launch Pad 3 incorporates ground services storage and control, lightning protection masts, liquid and compressed gas storage and water deluge tanks for launch operations;
- Satellite Tracking Station: an area of hardstanding housing satellite tracking and telemetry devices located on the Lamba Ness peninsula;
- Rocket Hall 2 of Integration Hangar A: the building where the Orbex PRIME Launch Vehicles is assembled and the payload(s) integrated;
- Administration Building and Hazardous Materials Store located adjacent to the Launch Site Processing Facility (LSPF) on the LNLS;
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

3.5.3 The Applicant will use only Launch Pad 3 at SaxaVord Spaceport. A plan showing Launch Pad 3 layout is included for information as Drawing 3.3 in Volume III.

3.6 Environmental Zone of Influence

3.6.1 For the purposes of this AEE, the EZI is based on and comprises the proposed launch flight corridors for both sub-orbital and orbital trajectories (which extend in a northerly direction over the sea along azimuths of 085 - 100 degrees from the equator) and all study areas required for the technical disciplines included in the AEE.

3.6.2 The North Atlantic EZI (incorporating drop zones for the first stage, interstage and fairings) is indicated on Figure 3.1 and presented in more detail on Drawings 10.1 and 10.2. The Pacific EZI (incorporating drop zone for the second stage) is indicated on Figure 3.2 and presented in more detail on Drawing 10.6.

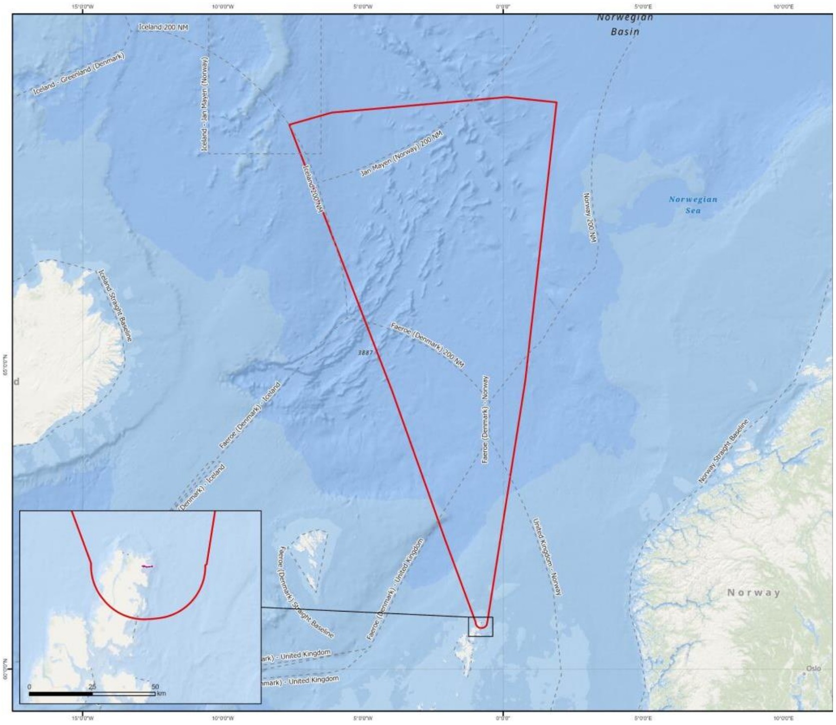

Figure 3.1 Orbex PRIME North Atlantic EZI

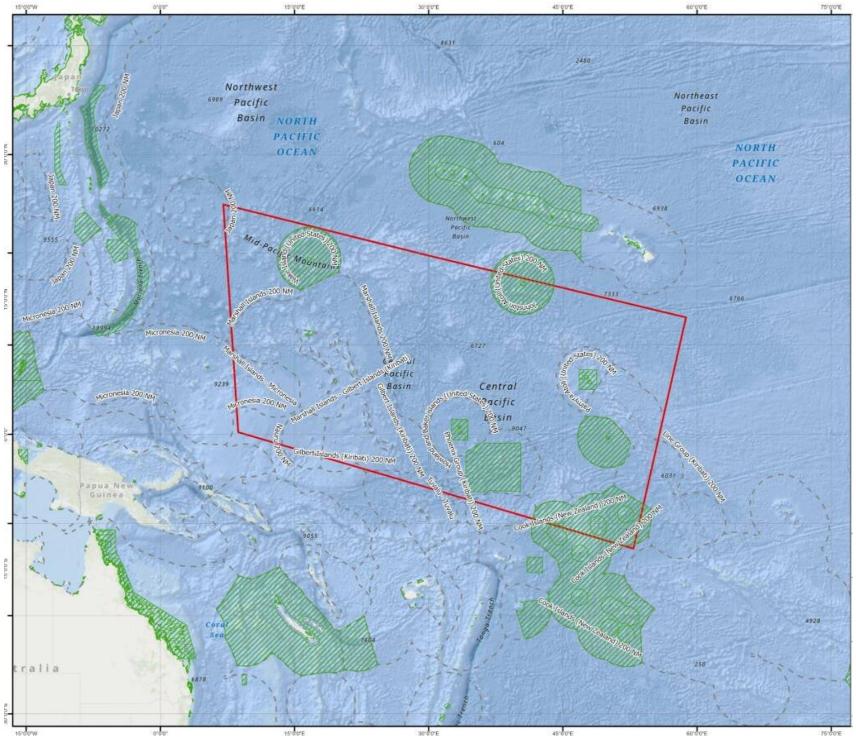

Figure 3.2 Orbex PRIME Pacific EZI

3.6.3 Within the EZI, the study area(s) required for each technical discipline assessed vary and as such the rationale for each study area has been included in relevant technical chapter. Individual study areas are shown in detail on Drawing 2.1.

3.7 Environmental Budget

3.7.1 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own environmental budget of 30 launches per year.

3.7.2 Subject to securing the appropriate permissions, consents and licences, the intention is to initiate first launch as soon as Q4 2025 and then increase cadence to 10 launches per year.

3.7.3 Whilst the Applicant has not yet determined a specific timeframe for operations, when required for the purposes of this AEE an operational phase of 30 years (equating to 300 launches) has been assumed, aligning with the current land lease for SaxaVord Spaceport. This applies in particular to the process of calculating total mass of returning components, required for the Marine and Transboundary assessment (Chapter 10).

3.7.4 For other technical disciplines the appropriate timeframe for assessment varies – for example for ecology/ornithology the appropriate timeframe is considered generally to be a year due to breeding seasonality, and similarly cumulative noise effects are assessed over the period of a year. Whereas for air quality, due to the fact that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to the baseline state for all environmental topics between launches (i.e., no more than one launch within a 24-hour period) the appropriate assessment period is considered to be a single launch. Due to this variance between technical disciplines, appropriate timescales for assessment are detailed in each technical chapter.

3.8 Environmentally Sensitive Periods of Time

No-launch window

3.8.1 Following consultation with NatureScot during the planning application stage for the Spaceport, SaxaVord Spaceport committed to a no-launch window whereby no launches will be carried out between mid-May and the end of June so as to avoid disturbing birds during the critical incubation and early brooding period. The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.

Night-time Operations

3.8.2 Shetland has long hours of daylight in the summer months, but long hours of darkness in winter. In Shetland in winter at this latitude it can be dark from 3pm through to 9am.

3.8.3 However, for the purposes of this AEE night-time effects are relevant to the noise impact assessment and as such the night-time period has been assumed to be 23:00 – 07:00, as defined in Noise Guidance Document Planning Advice Note (PAN)1/2011 and Technical Advice Notes (TAN) and based on the period of time when the population is likely to be asleep or at rest.

3.8.4 Of the proposed 10 launches per year, when taking into account the no-launch window agreed between mid-May to the end of June, the Applicant anticipates that in any one month there will be a maximum of two launches of the Orbex PRIME Launch Vehicle. Given the proposed frequency of launches and the short duration of the associated noise events adverse effects associated with sleep disturbance due to night-time launches are considered to be minimal.

3.9 Proposed Project Infrastructure

Launch Pad 3 Infrastructure

3.9.1 A Launch Pad 3 layout plan is provided as Drawing 3.3 in Volume III.

3.9.2 Launch Pad 3 comprises a concrete slab with a launch pit sunk into it and a launch platform and strongback on which the Orbex PRIME Launch Vehicle will sit for launch. The launch platform is a metal structure comprising the strongback support structure, a deluge water/flame propagation area, and flame diverter. The launch platform also integrates rigid piping from a commodities storage area to supply cryogenic fuel, oxidiser and pressurant to the Orbex PRIME Launch Vehicle.

3.9.3 The water deluge system comprises an above ground water supply tank (approximately 50,000 l) behind the western earth berm, and a buried below ground capture / collection tank (approximately 50,000 l) and associated pump. The deluge system delivers a high quantity of water over a short period of time to dampen acoustic loads on the launch pad and the Orbex PRIME Launch Vehicle at the time of lift-off as well as reducing the temperature of the exhaust gases to provide protection to the surrounding habitats. The water deluge system is only used during a launch event. The deluge system also protects the launch pad infrastructure ensuring minimum wear minimising servicing of the launch pad between launch campaigns.

3.9.4 The launch pad installation provides a drainage and collection system for collecting water from the deluge system. The concrete slab is surrounded on three sides by a wall to contain any deluge water. The slab falls towards the launch pit, such that any surface and deluge water will run-off into the launch pit. The launch pit is connected to a culvert via a manhole with a penstock valve permitting water to be diverted to an interceptor/storage tank (for collection and removal for off-site treatment) during fuelling and launch activities. When no launch activities are in operation, the penstock valve on the launch pit is maintained open such that rainwater run-off from the launch pit will discharge into a filter trench prior to sea outfall.

3.9.5 The strongback is a piece of equipment used to erect and support the Orbex PRIME Launch Vehicle during launch operations. It comprises a permanent steel lattice structure fixed to the launch platform of similar height to the Orbex PRIME Launch Vehicle. The strongback is incorporated into the launch platform, and it is stored in a horizontal position when not in operation.

3.9.6 The flame deflector unit is designed to allow the hot exhaust gases to be redirected away from the Orbex PRIME Launch Vehicle. The flame deflector is a triangular steel structure to divert the flames away from beneath the Orbex PRIME Launch Vehicle and is approximately 2.9 m in height and 4.6 m at its base.

3.9.7 Launch Pad 3 includes areas for storage of fuels and gases using suitably qualified tanks. The Launch Pad 3 fuel storage area has a contained concrete surface with run-off directed into a channel which discharges into a full retention alarmed interceptor, before discharging into a drainage ditch.

3.9.8 A lightning mast is positioned at Launch Pad 3, comprising a telescopic tower which is extended during a launch to an operational position of 2 m higher than the Orbex PRIME Launch Vehicle / umbilical tower height. At all other times the lightning mast is retracted to its un-extended configuration of 25 m.

Launch Pad 3 Ground Support Equipment

3.9.9 Launch Pad 3 Ground Support Equipment (GSE) encompasses all vehicle specific installations on the launch pad infrastructure used to service and operate the Orbex PRIME Launch Vehicle during launch operations. A range of fuels, oxidisers, coolants, and inert gases required to support the launch is stored within dedicated holding areas for smaller supplier-provided containers (e.g. cylinders).

Table 3.1 Summary of GSE Commodity Storage

Commodity	Capacity	Comments
Commodities Store #1		
Bulk LPG	2 x 8 m^3 ISO	Clean LPG
Liquid Nitrogen	3 x 20 ft ISO	Holding dewars (tanks) supporting purging and cooling.
LPG	1 x 20 ft ISO	Sub-cooled LPG tank
Propane Conditioning Plant	1 x 20 ft ISO	Chilling unit
Gaseous Nitrogen	1 x bottle rack	Gaseous nitrogen for ground valves.
HVAC	n/a	The HVAC unit is capable of supplying HEPA-filtered air or gaseous nitrogen.
Commodities Store #2		
Liquid Oxygen (LOX)	1 x 20 ft ISO	LOX holding dewars and GSE with overground ducted electrical interfaces.
Liquid Nitrogen	1 x 20 ft ISO	Cryogenically cooled nitrogen holding dewars and GSE with overground ducted electrical interfaces. For purging and cooling LOX lines.
Gaseous Helium	5 x bottle rack	Gaseous helium for pressurisation system.
Helium Transfer System	4 dedicated areas	Helium processing / transfer system. For propellant pressurisation.
Water	50,000l	Above ground storage tank and pumps to supply water deluge.

3.10 Orbex PRIME Launch Vehicle

3.10.1 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage expendable liquid fuelled launch vehicle primarily comprised of a carbon fibre structure and designed to launch payloads of up to 180 kg into both sub-orbital and orbital trajectories.

3.10.2 The Orbex PRIME Launch Vehicle composition includes carbon fibre reinforced plastic (CFRP), aluminium alloys, metal alloys, stainless steel, copper, ceramics, polymers/plastics, and batteries in varying quantities. The second stage incorporates small quantities of gaseous helium for use in the reaction control system. No pyrotechnics form any part of the Launch Vehicle.

3.10.3 The fuel for both the first and second stages is LPG with LOX as the oxidiser. He is utilised on both stages for pressuring the fuel and oxidiser tanks.

3.10.4 Orbex intends in the future to utilise commercial bio-LPG; however, for the initial launches will use standard LPG due to cost and simplicity of operation. As such, the AEE has been carried out on the basis that standard LPG is used.

3.10.5 Whilst the Orbex PRIME Launch vehicle is designed to be reusable, at the current stage of technology development, re-use / recovery processes are not planned until later flights and following technology testing and validation. As such for the purposes of this AEE the Orbex PRIME Launch Vehicle is considered to be expendable with no recovery planned.

3.10.6 A high-level specification is provided in Figure 3.3 highlighting the main elements of the Orbex PRIME Launch Vehicle.

Launch Vehicle Parameters		
Diameter	1.45 m	
Length	19 m	
Structure	Composite	
No. of stages	2	
Engine types	Cryogenic bi-liquid	
Propellants/ Oxidiser	LOX/LPG	
	Stage 1	Stage 2
No. of engines	6	1

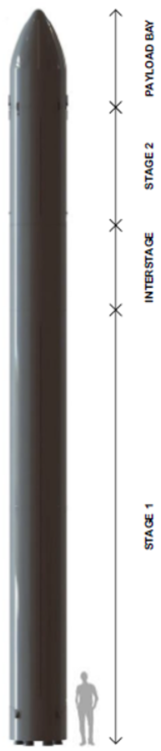

Figure 3.3 Generic Structure and Specification of the Orbex Prime Launch Vehicle

3.10.7 The Orbex PRIME Launch Vehicle uses seven engines; six of which are fitted to the first stage with the final engine fitted to the second stage which doubles as an orbital transfer vehicle.

3.10.8 A fuel mix of LPG and LOX as oxidiser is used as propellant on the combustion engines on both the first and second stages.

First Stage

3.10.9 The first stage of the Orbex PRIME Launch Vehicle is 13.7 m in length and 1.45 m in diameter and includes six engines, a set of carbon fibre coaxial tanks (helium, LPG, and LOX) that form the structure, a suite of electronics to manage the engines, and the Flight Termination System (FTS). As this stage primarily contains the propellent tanks and engines it may contain residual amounts of LPG-LOX on return to earth.

Interstage

3.10.10the Interstage is a composite structure that connects the first and second stages and houses the pneumatic pushers that allow the first and second stage to separate during flight. It serves as a protection mechanism for the second stage engine. The interstage will return to earth.

Second Stage

3.10.11The second stage contains the structure, propulsion, and avionics to carry the payload to its orbital destination. It shares the carbon fibre coaxial tank structure of the first stage but is furnished with a single engine optimised to operate in vacuum. The second stage doubles as the Orbital Transfer Vehicle (OTV) and carries the customer payload into orbit. It incorporates a standard payload adapter and is enclosed in a composite fairing.

3.10.12The second stage is 4.6 m in length and 1.45 m in diameter. When the second stage is integrated into the vehicle it adds an additional 4 m of length to the Orbex PRIME Launch Vehicle (the difference in length results from 0.6 m overlap with the interstage).

3.10.13Following payload deployment in orbit, the second stage will also return to earth and may contain residual amounts of LPG-LOX.

Payload Bay / Fairings

3.10.14The payload bay, comprising the fairings, is a conical structure at the top of the Orbex PRIME Launch Vehicle that protects the payload during the first phase of a launch, and the payload accommodation module, which hosts the customer payload and the vehicle's avionics and control systems. These items are constructed from composite layers, primarily carbon fibre reinforced polymers, and measure approximately 2.1 m in length with a maximum combined diameter of 1.45 m. The payload bay and fairings will return to earth.

3.11 Project Operations

3.11.1 Launches of the Orbex PRIME Launch Vehicle may occur at any time, with time of launch dependent on the orbital parameters required by the payload customer.

3.11.2 Full details of launch operations carried out during an Orbex PRIME campaign are contained within the Orbex Safety Operations Manual included separately as part of the launch operator licence application. The key steps in a representative typical launch campaign are set out below.

Launch Frequency and Duration

3.11.3 The Applicant's environmental budget is for a maximum of 10 launches per year. In terms of launch frequency, it is anticipated that there will be no more than two launches per month, and launches carried out between mid-May to end of June each year.

3.11.4 The duration of each Orbex PRIME launch campaign is expected to run for around eight weeks, of which the final four weeks will take place at SaxaVord Spaceport. For the purposes of this AEE, the launch campaign is therefore considered to start at the time that the first Orbex PRIME Launch Vehicle components arrive at the LNLS and continue through the launch activity and up until the spaceport has been returned to its pre-campaign state, i.e. all equipment has been returned to a safe/stowed state.

3.11.5 As shown in Figure 3.4 launch campaign will contain provision for several 'flight windows', i.e. a period during which a launch is permitted to be attempted by the CAA license conditions. Typically, each flight window will extend for 3 – 4 days and a launch campaign will contain a primary flight window with at least one backup.

3.11.6 Within each flight window there are several 'launch windows' during which the conditions are sufficient to reach the required orbit allowing for the launch vehicle performance. It is important to note that launches at different times of the day, and on different days, achieve different orbits with respect to the satellite's Earth viewing conditions.

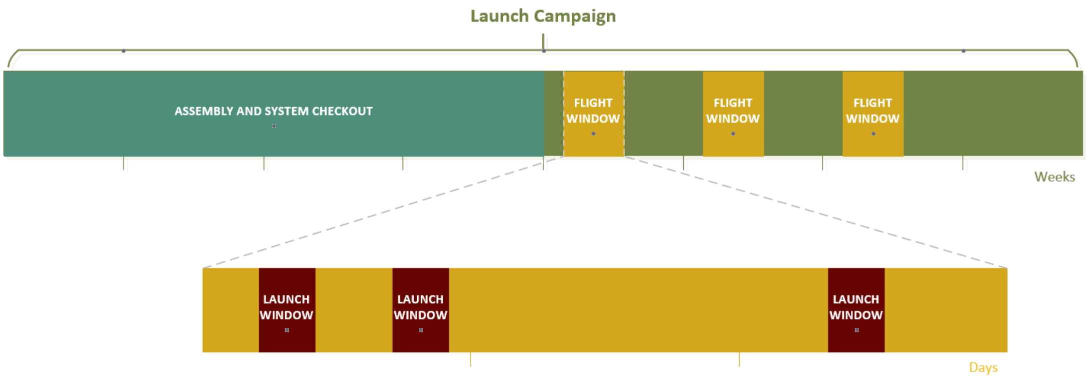

Figure 3.4 Orbex PRIME Launch Campaign

3.11.7 Timings included in this section are based on current understanding of the process and may be subject to change; however, an assumption of four weeks operational campaign at the LNLS around each launch is considered appropriate.

Fuel and Propellant Transportation and Storage

3.11.8 Fuels and propellants are transported to SaxaVord Spaceport in ISO road containers and stored in the Spaceport delivery holding area located at the Spaceport entrance prior to being transferred to the suitably tanks at Launch Pad 3. At Launch Pad 3 the tanks are stored in the designated protected areas as shown on Drawing 3.3.

3.11.9 The maximum quantities representing the worst-case scenario of storage during Orbex PRIME launch campaigns are set out in Table 3.2.

Table 3.2 – Launch Campaign Maximum (Worst Case) Materials Inventory

Material	Mass	State	Purpose
LOX	45,640	L	Oxidiser (LV propellant)
LPG Bulk	12,600	L	Pre-treated fuel (LV propellant)
LPG Clean	10,600	L	Fuel (LV propellant)
LIN	64,489	L	Subcooling LPG
Water (Clean)	50,000	L	Maximum storage capacity of clean water for deluge system.
Water (Recovered)	50,000	L	Theoretical maximum water volume recovered following launch event and associated deluge action.
Helium	160	G	Pressurant used in the launch vehicle tank system.
Nitrogen	1,200	G	Purge the system prior to operations

3.11.10 None of the proposed materials or volumes exceed the lower-tier of the Control of Major Accident Hazards Regulations (2015) (COMAH) threshold. It is not expected that any substance will exceed the COMAH threshold as a single material or under the aggregation rule, nor will a Hazardous Substance Consent be required.

Launch Vehicle Preparation

3.11.11 All operations by the Applicant at the LNLS are required to align with the SaxaVord Spaceport Operational Environmental Management Plan to minimise environmental effects.

3.11.12 The Orbex PRIME Launch Vehicle components arrive to the LNLS in separate shipping containers equipped with environmental controls (humidity and temperature) and damping to maintain shock loads below tolerated thresholds. Once the components reach the Integration Hangar, the containers are unloaded from the transport vehicle in front of the delivery entrance. The components then undergo a sequence of cleaning, testing, and preparing operations to get them ready for integration.

3.11.13 Integration dollies are assembled as a transfer vehicle for the Orbex PRIME Launch Vehicle in preparation for the transfer to Launch Pad 3 for wet dress rehearsal.

Wet Dress Rehearsal

3.11.14 A wet dress rehearsal comprising a range of activities including vehicle propellant loading (but no ignition) is conducted with the Orbex PRIME Launch Vehicle in launch position at Launch Pad 3.

3.11.15 The Applicant will not carry out any hotfire or static engine tests at SaxaVord Spaceport.

Payload Integration

3.11.16 Following successful wet dress rehearsal, the Orbex PRIME Launch Vehicle is rolled back to the Integration Hangar for payload integration and preparation for launch. The payload is integrated onto the second stage (orbital) and enclosed using the fairing. The first stage will then be integrated with the second stage and the whole assembly mounted together.

3.11.17 The Orbex PRIME Launch Vehicle will then be rolled out of the Integration Hangar using the integration dollies and transferred to the launch platform ('strongback') on Launch Pad 3. HVAC systems will maintain the temperature and humidity control of the payload in the Orbex PRIME Launch Vehicle whilst it is in the transport vehicle and when installed on the strongback. The HVAC unit is capable of supplying High Efficiency Particulate Air (HEPA)-filtered air or gaseous nitrogen.

Fuel and Propellant Loading

3.11.18 The Orbex PRIME Launch Vehicle uses LOX and LPG which are transferred from the ground storage tanks to the Orbex PRIME Launch Vehicle once on Launch Pad 3. Loss of containment is assessed by continual monitoring of tanks, there is no capability to divert fluids from compromised containers i.e. no reserve tanks to put fluids into if one is leaking.

3.11.19 Fuel and propellant loading begin as soon as the Orbex PRIME Launch Vehicle is erected on the launch platform and inspections completed. Firstly, umbilicals are connected to the Orbex PRIME Launch Vehicle, and a series of electrical and pneumatic checks performed to ensure all systems are working as intended. After the successful checkouts, the LNLS is evacuated and the Orbex PRIME Launch Vehicle propellant tanks are filled with LPG and held under slight pressure. During the filling process all the instruments are continuously monitored.

3.11.20 The LOX lines are chilled prior to LOX filling. During this filling process the high-pressure helium required for the launch will also be supplied to the Orbex PRIME Launch Vehicle through umbilicals on the first and second stages.

3.11.21 Once the Orbex PRIME Launch Vehicle is fully fuelled final checks are performed and, if passed, the Orbex PRIME Launch Vehicle is designated "go for launch" by both Orbex and the Spaceport operator.

Test Launches

3.11.22 For the purposes of this AEE, test launches (a test launch event that proceeds beyond ignition and lift off) have been considered as full launches within the Applicant's environmental budget.

3.12 Launch Exclusion Zones

3.12.1 The public will be restricted from accessing the LNLS during launches, and at all times the launch pads and integration buildings of SaxaVord Spaceport will be fenced off from public access both to protect against livestock and for security reasons.

3.12.2 In order to provide public safety, measures to control land, air and marine exclusion zones will be implemented by the Applicant and enforced by the Spaceport operator at specific periods of the launch, including the run-up to and during launch. The exclusion areas will include an area around Launch Pad 3, nearshore and offshore marine areas, and an airspace structure.

3.12.3 The dimensions of the exclusion zones will be detailed fully in the Orbex PRIME Safety Case.

3.12.4 Figure 3.5 shows the intended land exclusion areas for sun synchronous orbital launches of the Orbex PRIME Launch Vehicle, which fits within the intended LEZ of SaxaVord Spaceport (Figure 3.6).

Figure 3.5 Orbex PRIME SSO Land Exclusion Zone

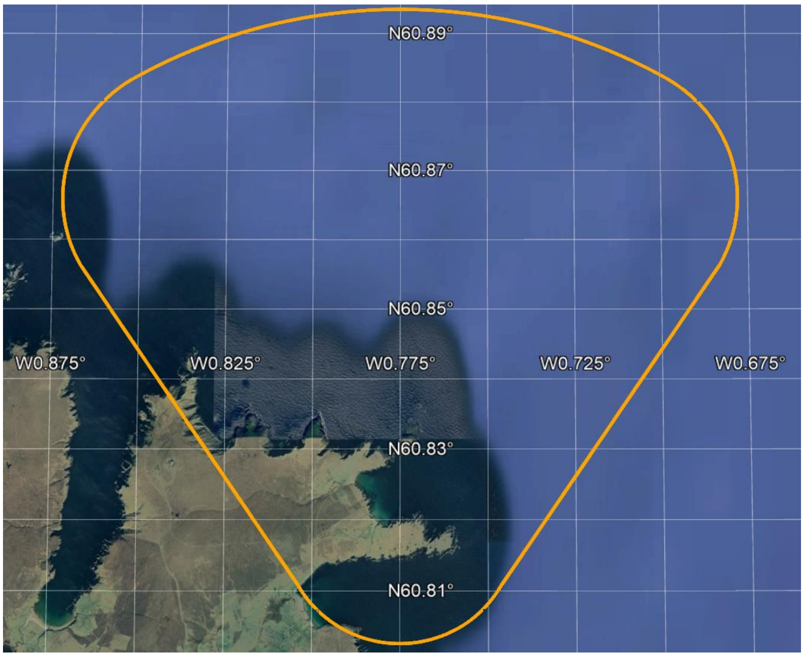

Figure 3.6 SaxaVord Spaceport LEZ

3.13 Mission Profile

3.13.1 The Orbex PRIME Launch Vehicle is deployed into high inclination orbits including polar and sun-synchronous orbits. The typical flight profile is illustrated on Figure 3.7.

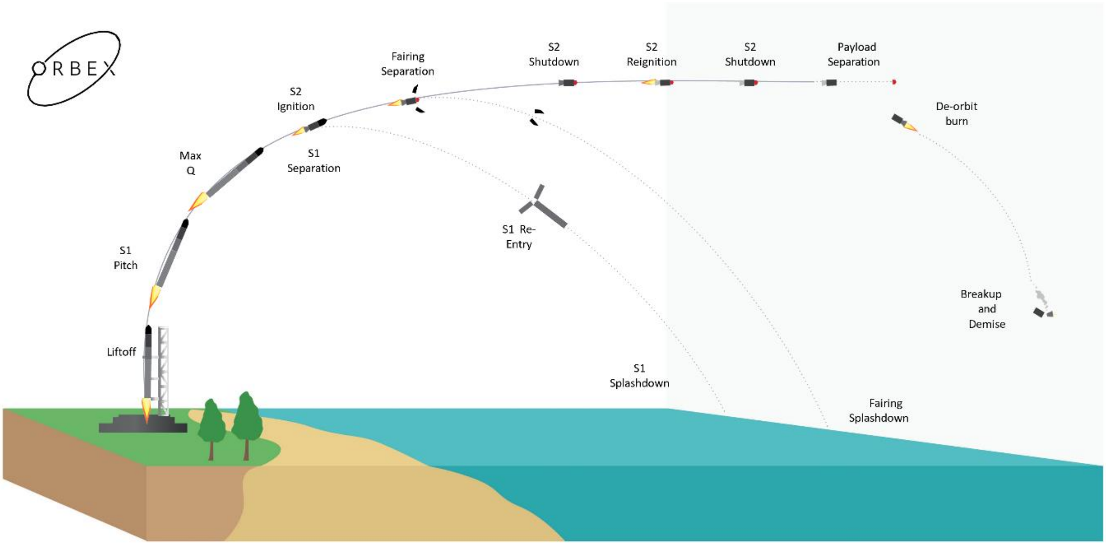

Figure 3.7 Typical Orbex PRIME Orbital Flight Profile

3.13.2 A typical orbital flight involves the Orbex PRIME Launch Vehicle taking off vertically from SaxaVord Spaceport and flying directly upwards for a short period before pitching over to a horizontal orientation and accelerating towards orbital velocity. The first stage ascent operates for approximately 167 seconds before engine cut off. Following engine cut off, the first stage is released prior to the second stage engine start sequence. Following separation, the first stage and interstage return to Earth in a pre-designated drop zone typically 8 - 10 minutes after launch.

3.13.3 Following stage separation, the second stage ignites and carries the vehicle to orbit, with the payload bay fairings being dropped as the second stage reaches space. This initial burn lasts approximately five minutes, and it delivers the vehicle to the required elliptic orbit. Another second stage engine ignition occurs to circularise the final orbit, at which point, the payload(s) is deployed.

3.13.4 After separating the payload(s), the second stage will complete an additional re-entry burn and re-enter the Earth's atmosphere, leaving no debris in space. It is anticipated that the second stage will burn up on re-entry, however this has not yet been confirmed. If the second stage does not burn up on re-entry, it is expected not to fragment in the atmosphere but rather stay as a single returning component resulting in minimal debris.

3.13.5 Re-entry of orbital stages is not currently within the scope of AEE for Launch Operator licence applications; however, at the request of the Applicant and to provide whole life cycle analysis, the return to earth of the Orbex PRIME orbital second stage has been considered in this AEE.

3.13.6 Drop zones are trajectory-dependant, and therefore the EZI for the AEE has assessed drop zones for trajectories ranging from 085 – 100 degrees from the equator. All future launch campaigns will be aligned within the identified EZI. Each launch trajectory will be unique to the requirements of that launch campaign and the payload customers, but all launch campaigns will include contingency for modification as required due to meteorological or other aspects at the date/time of launch.

3.13.7 Physical in-space testing of the Launch Vehicle is required before it can be known whether the second stage components will burn up entirely during re-entry. As such, for this AEE, a worst-case assumption has been made that the second stage components will also return to Earth.

Flight Termination

3.13.8 The flight termination system (FTS) is non-explosive; instead cutting off power and thrust and resulting in the Orbex PRIME Launch Vehicle decelerating and returning to earth. The FTS is controlled by the SaxaVord Spaceport range control officer who will terminate the launch if the Orbex PRIME Launch Vehicle experiences anomalies. The FTS tracks the predicted impact points in real time, and terminates thrust if activated, resulting in the Orbex PRIME Launch Vehicle continuing on a ballistic trajectory until it reaches the earth surface.

Launch Trajectory and Recovery Operations

3.13.9 At the current stage of technology development, re-use / recovery processes are not planned until later flights and following technology testing and validation.

3.13.10 The proposed trajectories of the Orbex PRIME Launch Vehicle will have an overall northerly direction from SaxaVord Spaceport. Two drop zones are expected per launch (first stage, interstage and fairings; second stage re-entry).

3.13.11 Stage deposits can be summarised as follows:

- First Stage, Interstage and Fairing – these are designed to breakup on descent / on ocean impact and sink within the modelled drop zone. For trajectories with drop zones within Icelandic waters, the Applicant will perform all reasonable efforts to recover any debris in line with international agreements.
- Second Stage – following on from assumptions made by the National Institute of Water and Atmospheric Research Ltd (NIWA 2016, NIWA 2017), it is anticipated that the second stage will burn up entirely in the atmosphere before impacting the sea surface. However, there are limited studies of carbon fibre demise on atmospheric re-entry, and it is not possible to confirm the extent to which the second stage will break up. As such, in order to assess the worst-case scenario, this AEE assumes that the second stage will return to Earth. The exact drop zone for second stage components is dependent on the trajectory but will be in the Pacific and no recovery is planned.

3.13.12 The UK Government has consulted with the governments of countries where the stages or fairings are predicted to land to come to an agreement to allow stages to fall in their waters (SaxaVord Spaceport, 2020). The Pacific EZI may overlap with the Exclusive Economic Zone (EEZs) of several countries, however the second stage will not be de-orbited on any trajectory where it will fall within the EEZs of any of these nations, unless prior permission is obtained.

3.13.13 As evidenced in Chapter 10, Vulnerable Marine Ecosystems (VMEs) are numerous in the North Atlantic EZI, particularly around the coasts of landmasses. The North Atlantic EZI also contains a small number of marine protected areas (MPAs) with benthic features. There are also multiple large MPAs within the Pacific EZI. None of the stages or fairings will be released on any trajectory where they could land in one of these areas.

3.13.14 Noting the conditions of the Memoranda of Understanding currently in place between the UK Government and the Governments of The Faroe Islands and Iceland respectively, the Applicant will carry out the following activities:

- The Applicant will make all reasonable efforts to avoid Orbex PRIME launch debris falling within the territory of Iceland.
- Prior to any launch activity, the Applicant will provide copies of any relevant Notices to Aviators or Notices to Mariners issued for the launch activity to the Government of The Faroe Islands and the Government of Iceland.
- On the day of launch, the Applicant will monitor the publicly available Automatic Identification Systems (AIS) information, to ensure that no fishing activity within the territories of the Faroes Islands is placed at risk by the Applicant's activities.

3.13.15 The Applicant is aware of the intergovernmental agreements with Jan Mayen and Norway that there should be no dropped debris within 12 nautical miles of the coasts of both Jan Mayen and Norway and confirms that planned trajectories and drop zones will be designed such that no debris falls either over land or within 12 nautical miles of the coast. This applies both to nominal and off-nominal launches. For off-nominal launch situations the Orbex PRIME Launch Vehicle FTS would be activated prior to the Orbex PRIME Launch Vehicle entering any area which could result in debris falling either over land or within 12 nautical miles of the coast.

3.13.16 With reference to the United Nations Convention on the Law of the Sea (UNCLOS) and associated directives to prevent, reduce and control anthropogenic input to the marine environment the Applicant will seek to minimise deposition of debris where possible, and in particular avoid MPAs/VMEs and other sensitive marine features.

3.13.17 There are currently no recovery operations planned to recover first or second stages or fairings from the Orbex PRIME Launch Vehicle from the Icelandic EEZ or any other oceanic area.. This is because at the current stage of technology development, re-use / recovery processes are not planned until later flights and following technology testing and validation. The Applicant notes that:

- Any returning components will be jettisoned to result in a minimum distance of 12 nautical miles from any coastline.
- Once at the bottom of the ocean, the stages, mainly constructed out of carbon fibre, will start an artificial reef and serve as a habitat for marine life, contributing to biodiversity in the area as assessed in more detail in Chapter 10.

- The cost of retrieving all hardware from launch campaigns at the current stage of development would make launching out of the UK cost prohibitive.

3.13.18 Therefore, it is considered that the cost and risk associated with recovery outweighs the potential benefits of removal of the debris at the current time. This will be reviewed as the programme progresses.

3.14 Off-Nominal Launch Scenarios

3.14.1 Scrubbed launches (launch events where the Applicant calls off the attempted launch prior to ignition) inherently have no significant environmental effects and therefore are not considered further in the AEE.

3.14.2 Off-nominal launch events (when the launch event proceeds beyond ignition but does not perform within expected/acceptable limits) are considered further in Chapter 9 (Accidents) and Chapter 10 of this AEE Report.

3.14.3 Aborted launches (where the Applicant calls off the attempted launch following ignition – either resulting in the Launch Vehicle remaining on the pad, or the Applicant activating the FTS in flight) are considered interchangeable with off-nominal launch scenarios.

3.14.4 It is anticipated that the deflagration following ignition of propellant during any launch failure will create a short-lived initial fireball potentially extending several tens of metres from the pad, with the residual propellant rapidly burning off over several minutes.

3.14.5 The initial deflagration radius is not expected to extend beyond the boundary of the Proposed Project and the duration of any subsequent propellant burn-off would be minimal in the open air.

3.14.6 Peat depth and condition surveys have now completed at SaxaVord Spaceport. The NatureScot classification of peatland at the Spaceport is Class 5 (peat soil with areas of bare soil), which is consistent with data obtained during site surveys. It is considered that the relative flammability of the substrate is low, and that it will not be at risk of ignition following a propellant deflagration.

3.14.7 Firefighting water will be limited to damping / suppression and hence not of a volume sufficient to mobilise any combustion products. Foam is highly unlikely to be deployed given the rapid burnout of any fires.

3.15 Post Launch Operations

3.15.1 Post launch operations involve the inspection, demobilisation, and movement of all temporary Orbex equipment into storage. The launch platform, storage tanks and line will remain in situ as the Applicant has agreed sole use of Launch Pad 3 with SaxaVord Spaceport.

3.16 References

Orbex Prime and Sutherland Spaceport AEE Version 1. Orbital Express Launch Limited, September 2024.

Chapter 4 Climate Change and Resilience

4. Climate Change

4. Climate Change

4.1 Introduction

4.1.1 This chapter evaluates the potential impact of the Proposed Project on climate change due to its greenhouse gas emissions (GHG), as well as assessing the vulnerability of the Proposed Project to climate change effects and the need for adaptation measures where identified.

4.1.2 The Proposed Project will have an impact on climate change due to GHG emissions resulting from transportation of the Orbex PRIME Launch Vehicle and associated equipment, and fuel consumption by the Launch Vehicle. A reasonable worst-case scenario for carbon dioxide equivalent emissions associated with the Proposed Project has been evaluated as part of a GHG assessment.

4.1.3 Following the identification of potential effects, suitable mitigation measures have been proposed, and an assessment of residual effects on environmental receptors sensitive to climate change has been undertaken.

4.2 Legislation, Policy and Guidelines

Space Industry Act

4.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK’s territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

4.2.2 As the Applicant wishes to become a spaceflight operator and launch the Orbex PRIME Launch Vehicle from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

4.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Additional Legislation

4.2.4 Relevant legislation and guidance documents have been reviewed as part of this climate change assessment. Of particular relevance are:

- The Climate Change (Scotland) Act 2009 which required ministers to establish Scotland's programme for climate change adaptation;
- The Paris Agreement 2015 which sets a target for net zero global carbon emissions in the second half of the 21st century to limit the global temperature increase to less than 2°C above pre-industrial levels. A key aim of this agreement is to strengthen national responses to combat climate change and adapt to its effects. The Paris Agreement was ratified by the UK in 2016; and
- Climate Change (Emissions Reduction Targets) (Scotland) Act 2024 which sets Scottish targets for the reduction of GHG emissions to deliver on the Paris Agreement and Net Zero commitments, and makes provision about advice, plans and reports in relation to those targets. The Act sets out five-year budgeting periods and a Net Zero target for 2045.

Planning Policy

4.2.5 The following policies have been taken into consideration:

- Scottish Government National Planning Policy Framework 4, in particular Policy 2 on project greenhouse gas emissions;
- Scottish Government Climate Change Plan (CCP) (2018-2032) which is a roadmap for Scotland to transition to a low carbon economy;
- Shetland Islands Council Net Zero Strategy, which outlines pragmatic steps for the Shetland Islands to reach as close to net zero as practicable by 2045, noting the islands' unique challenges in pursuit of this ambition; and
- Shetland Islands Local Development Plan 2014 policies GP1 (Sustainable Development) and GP2 (General Requirements for All Development). This LDP is still extant until its expected replacement in 2028.

Guidance

4.2.6 The following best practice guidance for assessing climate change effects has been taken into account:

- Guidance for the Assessment of Environmental Effects (CAA, 2021);
- 2015 IEMA guidance on Climate Resilience and Adaptation in EIA (amended in 2020) provides a framework for the effective consideration of climate change resilience and adaptation through EIA procedures. It includes case studies of EIAs which have considered climate adaptation and resilience issues, reflecting legislative developments and evolving practice;
- Guidance to the Regulator on Environmental Objectives relating to the exercise of its functions under the Space Industry Act 2018; and
- Climate Change Allowance for Flood Risk Assessment in Land Use Planning.

Considerations noted in the DfT guidance for the regulator

4.2.7 The Department for Transport issued 'Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK.

4.2.8 The guidance notes several subject areas which are recommended for consideration by the regulator when assessing AEE reports. The CAA has not yet provided detailed guidance on the exact treatment of these areas; but for completeness, the provisional approaches taken in this AEE are summarised below.

Alternative Fuels

4.2.9 Calculated emissions per launch of the Orbex PRIME Launch Vehicle in this AEE assume that liquified petroleum gas (LPG - a mixture of propane and butane) is the fuel, with liquid oxygen (LOX) acting as the oxidant. Greenhouse gas emissions per launch using liquid or solid hydrocarbon fuels will be of a similar magnitude and other primary fossil hydrocarbon fuels (such as RP-1) will produce a similar quantity of GHGs.

4.2.10 Liquid hydrogen does have precedent as a fuel for much larger launch vehicles and can represent a low or zero GHG fuel depending on the means of production – green (renewably-powered electrolytic) hydrogen is still at a very early developmental stage in the UK as a commercial proposition. The hydrogen fuel used by NASA, for instance, is produced from steam methane reformation and uses a methane feedstock. The residual carbon dioxide is most likely emitted to air meaning that this option cannot be considered low carbon.

4.2.11 Liquid hydrogen fuel, howsoever derived, requires cryogenic cooling, which currently carries disproportionate weight and energy penalties for small launch vehicles. It is not considered a viable alternative to LPG for the Proposed Project at the time of writing.

4.2.12 The biologically derived alkane market in the UK is at present looking to develop the production of methane and LPG from waste biological material. The Orbex PRIME Launch Vehicle has been designed around the particular properties of LPG, including calorific value but also the handling advantages of heavier alkanes when compared to methane and the well-developed commercial LPG dispensation and distribution systems in the UK. The Applicant intends in the future to utilise commercial bio-LPG; however, for the initial launches will use standard LPG due to cost and simplicity of operation. As such, the AEE has been carried out on the basis that standard LPG is used.

Efficiency Savings

4.2.13 There are not expected to be material opportunities for fuel savings (and hence GHG reductions) on a per-launch basis as fuel is inherently optimised to allow maximum payload per launch plus contingency. Incremental gains in efficiency through design iterations and use of more lightweight materials may be possible as the relevant technologies develop.

Ozone Depletion

4.2.14 Stratospheric ozone depletion by the reaction with hydrocarbon exhaust compounds is reported to be related to the action of black carbon caused by the incomplete combustion of hydrocarbons. Black carbon increases radiative forcing in the stratosphere, which leads in turn to warming in that atmospheric layer and an increase in the rate of reactions which contribute to ozone depletion.

4.2.15 Orbex PRIME Launch Vehicles uses LPG as a fuel. Whilst the black carbon issue is more commonly associated with longer chain alkane fuel mixtures (i.e. kerosene analogues like RP-1); there is little research into stratospheric LPG combustion a result of the rarity (to date) of LPG applications in space flight. However, a well-understood relationship is that the shorter the alkane, the less potential for black carbon formation (Burkhardt et. al., 2004). An oil-fired combustion process has potential to generate significant black smoke whilst an equivalent methane-fired process will produce a vanishingly small quantity of black carbon by comparison. Whilst propane and butane (the components of LPG) are longer alkane molecules than methane, they are considerably shorter than the range of alkanes present in RP-1. LPG is therefore expected to produce less black carbon on a calorific basis than an RP-1 counterfactual.

4.2.16 This issue of black carbon is most effectively mitigated in practice for any hydrocarbon fuel by optimising fuel mixing ratios during combustion; the desired outcome is for the maximum calorific value to be extracted from the fuel rather than wastage from incomplete combustion and black carbon formation.

4.2.17 The most effective mitigation against black carbon will be the sectoral transition to carbon-free fuels; this is not an issue that biofuels will address due to their fundamental chemical similarity to the replaced fossil fuels.

Local meteorology

4.2.18 Weather and climate should not be conflated. Local meteorological conditions are not considered a relevant consideration in the context of the climate effects of the Proposed Project but are considered by the air quality assessment (Chapter 7) in terms of their influence on dispersion of potential air pollutants formed by combustion.

Offsetting

4.2.19 The Proposed Project has no scope for direct offsetting as it is a transient activity with no physical footprint where land use change could be explored. The purchase of third-party carbon credits is not considered to offer a guarantee of genuine additive GHG savings in the current market. This will be reviewed in future to assess the viability of purchasing credits which genuinely correspond to long-term GHG removal, but the Applicant is currently advised against offsetting as a mitigation strategy.

Other considerations

4.2.20 The Orbex PRIME Launch Vehicle relies on resonance ignition to achieve propellant combustion. This introduces no additional combustion-derived pollutants into the atmosphere. A counterfactual system utilising (for example) pyrophoric ignition materials would have a greater overall pollution burden.

4.3 Assessment Methodology and Significance Criteria

4.3.1 The following assessments have been undertaken as part of this chapter:

- a GHG assessment to evaluate the potential effects of the Proposed Project on climate change;
- an assessment of potentially significant climate change variables on the Proposed Project; and,
- an assessment of the residual effects on environmental receptors sensitive to climate change.

Environmental Zone of Influence

4.3.2 The scope of the GHG assessment includes operational emissions of the Proposed Project which are predominated by emissions from launches.

4.3.3 The study area for potential adverse climate change effects of and on the Proposed Project is restricted to the Proposed Project boundary and the transport network utilised for the transport of materials and personnel. The study area is included in the wider environmental zone of influence (EZI) considered for the AEE.

Desk Study

4.3.4 An assessment has been undertaken of current and future climate trends in the EZI, including mean air temperature, wind speed and precipitation rate. The following sources were used to characterise existing or future baseline conditions:

- Met Office UK Climate Averages;
- UKCP18 Climate Projections; and
- UK local authority and regional carbon dioxide emissions national statistics.

Assessment of Potential Effect Significance

4.3.5 For the purposes of this chapter, two assessments of potential effect significance have been carried out, a GHG assessment to evaluate the potential effects of the Proposed Project on climate change and an assessment of potentially significant climate change impacts on the Proposed Project, both at the time of the first launch and at the further future years covered by the climatic modelling considered.

4.3.6 The sensitivity of the receptor has been evaluated, along with the significance of effect and the magnitude of the impact, based on the subjective judgement of the assessor. The terminology used has been defined below.

Sensitivity

4.3.7 An evaluation of the sensitivity of the Proposed Project in terms of climate change and the sensitivity of the global atmospheric environment as the receiving body for GHG emissions, was undertaken using the following terminology:

- High Sensitivity - Absolutely reliant on specific climate/global atmospheric conditions prevailing.

- Medium Sensitivity - Affected by changes in climate/global atmospheric conditions but not dependent on specific conditions.
- Low Sensitivity - Hardly influenced by climate/global atmospheric conditions at all.

Magnitude of Impact

4.3.8 The magnitude of the impacts on baseline conditions has been assessed, and the following terminology has been used to define magnitude:

- High - A fundamental change (beneficial or adverse) to the baseline condition of the receptor, leading to total loss or major alteration of character. An impact on regional GHG emissions which causes a large net increase;
- Medium - A material change (beneficial or adverse) leading to partial loss or alteration of character. An impact on regional GHG emissions which causes an appreciable net increase;
- Low - A slight, detectable, alteration of the baseline condition which may be beneficial or adverse. An impact on regional GHG emissions which causes a measurable net increase;
- Negligible - A barely distinguishable change from baseline conditions. Changes in GHG emissions so low as to not be practically measurable.

Significance of Effect

4.3.9 Based on the sensitivity of receptors and magnitude of impact, the significance of effect has been professionally evaluated. Under environmental impact assessment legislation, major and moderate impacts are to be considered as significant:

- Major - A significant effect that is likely to be a material consideration in its own right. GHG emissions which represent a major proportion of regional totals;
- Moderate - A significant effect that may be a material consideration in combination with other significant effects but is unlikely to be a material consideration in its own right. GHG emissions which represent a recognisable change in regional totals;
- Minor - An effect that is not significant but may be of local concern. GHG emissions which though measurable do not materially affect regional totals; and
- Negligible - An effect that will result in no change to the existing environment.

Requirements for Mitigation

4.3.10 Standard mitigation measures must be implemented to lessen the impact of potentially significant climate effects on the Proposed Project, these have been outlined in Section 4.7.

4.3.11 IEMA best practice guidance considers all GHG emissions to be significant due to their contribution towards climate change; however, to assign any GHG emissions which are additive to the prevailing baseline as being of major significance is to ignore local context and the scale of the emissions produced by the Proposed Project, which is why the magnitude and significance descriptors above have been developed.

4.3.12 To mitigate against potential significant effects, a baseline carbon footprint is calculated and then used as a basis to reduce emissions.

Limitations to Assessment

4.3.13 The principal sources of uncertainty are:

- Natural climate variability resulting from natural external influences on climate or changes in the energy received from the sun;
- Climate models represent an incomplete understanding of Earth system processes; and,
- Uncertainty in future GHG emission trends in transport vectors associated with the Proposed Project.

4.4 Baseline Conditions

Current Baseline – Climatic Conditions

4.4.1 A local climate baseline is provided by Met Office Historic Climate Data which presents a set of 30-year averages, covering the period 1981-2010 for a range of parameters. This period was selected to match future Met Office projections which are currently baselined in 1980. The nearest meteorological Met Office data station to the site is Baltasound No. 2, which is located approximately 8 km to the south-west (60.749, -0.854). The data available for the Baltasound No. 2 data station comprises a representative baseline for the Proposed Project due to its close proximity, comparable altitude of 15 m above mean sea level, and the similar maritime setting on the east coast of Unst, northern Shetland. The data is presented in Table 4.1 and summarised below:

- The Baltasound No. 2 data station recorded an average annual maximum temperature of 10.2°C, 0.5°C lower than the average annual minimum temperature for Scotland.
- The average annual minimum temperature of 5.4°C was 1.2°C warmer than the average annual minimum temperature for Scotland (4.2°C).
- An annual average of 1,108.1 mm of rain was recorded by the Baltasound No. 2 data station. This is significantly less than the average annual rainfall for Scotland between 1981-2010 which stands at 1,570.9 mm.
- The monthly mean wind speed at 10 m in Unst is 13.4 knots, with the highest average wind speed recorded in the month of January, an average of 16.7 knots.

Table 4.1 – Climate Averages 1980-2010 recorded at Baltasound No.2 Station

Month	Maximum temperature (°C)	Minimum temperature (°C)	Days of air frost (days)	Rainfall (mm)	Days of rainfall ≥1 mm (days)	Monthly mean wind speed at 10 m (knots)
January	6.4	2	7.8	123	22	16.7
February	6	1.3	7.7	95.7	17.5	15.7
March	7.1	2.1	6.3	107.4	20.1	15.3
April	8.9	3.7	3.5	64.7	13.7	13.1
May	11	5.6	0.5	52.3	11.8	11.4
June	13.1	8	0	56.6	11	10.9
July	15	10.2	0	59.9	12	10.3
August	15.2	10.4	0	82.1	13.4	10.5
September	13.4	8.8	0.1	96	16.7	12.6
October	10.7	6.5	0.5	122.6	20.6	14.4
November	8.2	3.8	3.6	128	20.5	15
December	6.8	2.1	7.8	119.8	20.7	14.5
Annual	10.2	5.4	37.7	1108.1	200	13.4

Current Baseline – Greenhouse Gas Emissions

4.4.2 Local and regional Carbon Dioxide (CO_2) emissions data tables published by the UK Government contain historic emissions data for the period 2005 - 2022 for all UK local authorities and councils; at the time of writing in 2025 this is the most recent dataset available. The total emissions and emissions per capita in the Shetland Islands for the reported period are reproduced in **Error! Reference source not found.** and include all fossil fuel and land use / land use change factor (LULUCF) related GHG emissions. Between 2005 and 2022, CO_2 emissions per capita in the Shetland Islands have been on a downward trend with a small and expected uptick following the end of COVID restrictions in 2021.

Table 4.2 – Climate Averages 1980-2010 recorded at Baltasound No.2 Station

Year	Kilotons CO_2	Population ('000s)	Per Capita Emissions (tonnes)
2005	672.6	22.3	30.2
2006	667.9	22.2	30.1
2007	664.0	22.4	29.7
2008	652.9	22.5	29.0
2009	639.9	22.8	28.1

Year	Kilotons CO_2	Population ('000s)	Per Capita Emissions (tonnes)
2010	642.9	23.1	27.9
2011	634.8	23.2	27.3
2012	635.8	23.2	27.4
2013	623.4	23.2	26.9
2014	611.6	23.2	26.3
2015	604.7	23.2	26.0
2016	587.7	23.2	25.3
2017	578.9	23.1	25.0
2018	573.2	23.0	24.9
2019	568.3	23.0	24.7
2020	550.4	22.9	24.0
2021	558.8	22.9	24.4
2022	556.0	23.0	24.2

Future baseline

4.4.3 Climate projections for the periods 2020-2048 and 2050-2078 have been analysed to account for changing conditions over the proposed 50-year maximum design life of the built assets at the Proposed Project.

4.4.4 Representative Concentration Pathway 8.5 (RCP8.5) was utilised to capture the worst-case scenario future trends. RCP8.5 represents a pathway in which global population doubles to 12 billion, technology development and GDP growth is slow, and high fossil fuel consumption is sustained. This scenario assumes a culmination in radiative forcing levels of 8.5 W/m^2 by 2100.

4.4.5 The climate variables considered relevant to this assessment are mean air temperature, maximum air temperature, wind speed and precipitation.

4.4.6 The future baseline data is presented as a series of 12 outputs each representing a "member". Each member represents a plausible future climate scenario, with the ensemble members differing due to natural climate variability and uncertainty in global model physics. The 12 members therefore display the range of uncertainty in climate projections.

4.4.7 In general, the trends become more pronounced over time with more extreme trends arising by the late 2070s.

Mean Air Temperature

4.4.8 An increase in mean air temperature in Unst is expected in the 21st century. For the period 2020 - 2048, the annual mean air temperature at Unst is projected to be 1°C - 2°C higher than the 1981-2010 average. This rises to 2 - 3°C above baseline levels for the 2050 - 2078 timescale, according to 75% of member scenarios.

4.4.9 An identical trend is predicted for the maximum air temperature anomaly. However, there is greater uncertainty in predictions for the annual average minimum air temperature anomaly, this variable is projected to rise by between 1°C - 4°C above baseline levels under the RCP8.5 scenario.

4.4.10 The baseline maximum temperature recorded at Baltasound, Unst is 15.2°C for the month of August (see Table 4.1), and the highest temperature ever recorded by this weather station is 25°C in July 1958. The average maximum temperature in Unst over the baseline period is significantly lower than the UK average maximum temperature of 19.4°C for the month of July. As such, despite the projected warming, temperatures in Unst will remain comparatively low.

Wind Speed

4.4.11 In all member scenarios covering the 2020-2048 and 2050-78 periods, the annual average wind speed is predicted to be between 0-0.5 m/s lower than the 1981-2010 baseline levels. This minor decrease in wind speed applies to all seasons.

4.4.12 The baseline monthly mean wind speed at 10 m in Unst is 13.4 knots (6.9 m/s), which is higher than the UK average. Therefore, average wind speed in Unst will remain comparatively high, despite the projected reduction.

Precipitation Rate

4.4.13 A slight increase in the annual average precipitation rate is expected over the climatic modelling period. Throughout both the 2020 - 2048 and 2050 - 2078 periods, two thirds of member scenarios predict a 0-10% increase in the annual average precipitation rate in Unst compared to baseline levels.

4.4.14 Seasonal variation is predicted, with summer months expected to experience a slight decrease in the average precipitation rate, whilst winter months will see an increase.

4.5 Receptors Brought Forward For Assessment

4.5.1 The sensitive receptors in the instance of this climate change assessment are the Orbex PRIME Launch Vehicles and attendant vehicles and personnel for the Proposed Project itself. In terms of climate vulnerability and the global atmospheric environment as the receiving body for GHG emissions. No individual receptors have been selected for assessment.

4.6 Standard Mitigation

4.6.1 A range of standard mitigation measures have been implemented to lessen the impact of potentially significant climate effects on the Proposed Project:

- Lamba Ness has localised areas at risk from pluvial surface water flooding, meaning the site is vulnerable to heavy rainfall. Within the SaxaVord Spaceport Lamba Ness Launch Site there are small unnamed natural streams and watercourses, and drainage ditches have been cut in the flatter areas to aid drainage into these natural streams. A comprehensive drainage system has been implemented by SaxaVord Spaceport at the site, and this will act to mitigate flood risk during operation of the Proposed Project. Drainage works are the responsibility of SaxaVord Spaceport, but the Applicant will adhere to any associated management/operational plans required by SaxaVord Spaceport.

- Proposed Project activities will be suspended during extreme weather events to mitigate against health and safety risks for site personnel and potential damage to structures and equipment.

4.6.2 To mitigate against potential significant effects caused by the Proposed Project, the following measures will be applied to reduce resulting GHG emissions:

- Iterative increases in energy efficiency as data is collected from launches and used to inform the Launch Vehicle design process; and
- Surface and marine vehicle transport will similarly decarbonise over the later 2020s and 2030s reducing GHG emissions from these sources.

4.7 Potential Effects

Influence of the Development on Climate Change

4.7.1 An assessment of the likely GHG emissions resulting from the Proposed Project has been undertaken in accordance with the methodology specified in Section 4.4.

4.7.2 A number of input parameters were required in order to quantify the carbon footprint, these are specified in Table 4.3.

4.7.3 A full overview of the emissions factors and calculation data is provided in Appendix 4.1.

Table 4.3 – Greenhouse Gas Assessment Boundaries

Source of GHG Emissions	Input Data	Emissions Factor Source	Description
Transport	Distance travelled by HGV, tanker and ferry from point of origin	UK Government GHG Conversion Factors for Company Reporting 2024	GHG emissions from vehicles transporting Launch Vehicles and fuel to site
Launches	Mass of fuel consumed	UK Government GHG Conversion Factors for Company Reporting 2024	GHG emissions resulting from fuel consumption during launches

4.7.4 The transportation of payloads to SaxaVord Spaceport has been excluded from the assessment due to high levels of uncertainty around their source destinations. It can be assumed that this contribution will be very small for domestically produced payload items.

4.7.5 The emissions associated with a single launch of the Orbex PRIME Launch Vehicle have been calculated and can be simply factored to represent the emissions from multiple launches.

Table 4.4 Greenhouse gas emissions per launch

Source of GHG Emissions	GHG Emissions (tCO_2e)
Launch of Orbex PRIME Launch Vehicle	16.09
Transport of Orbex PRIME Launch Vehicle and equipment	12.24
Total	28.33

4.7.6 The major contributor to GHG emissions is the combustion of fuel during the actual launches.

4.7.7 The other major component of GHG emissions is from the transportation of the Orbex PRIME Launch Vehicle to the launch site from its assembly site at Forres. Emissions from the transportation of the Orbex Prime Launch Vehicle, fuel and oxidant are assumed to require a maximum of eight shipping containers (three large (40') and up to five small (20') loaded onto articulated lorries, travelling the distance from the works at Forres by road to Aberdeen. A further two road tankers, one for LPG fuel and another cryo tanker for LOX are assumed to originate from Grangemouth. A combination of ferry and road transport is assumed to deliver the loads from Aberdeen to Lerwick and thence to SaxaVord Spaceport.

4.7.8 The five smaller loads are principally ground-based equipment to be installed at SaxaVord Spaceport Launch Pad 3 and are associated with the Applicant's first launch. With the ground equipment installed during the commissioning of the Launch Pad 3, subsequent launch campaigns will not require as much ground-based equipment being transported to the spaceport and hence the transport contribution to GHG emissions will be lower. Distance and emission factor assumptions are presented in Appendix 4.1.

4.7.9 GHG emissions are assessed as a low impact given that they are too large to be considered negligible but do not represent a significant proportion of regional emissions. As such they are considered to represent no likely significant effect.

4.7.10 The effects of the GHG emissions caused by the Proposed Project are theoretically reversible as natural processes and emerging technologies such as Direct Air Capture can fix atmospheric carbon dioxide on a temporary or permanent basis. However, the Precautionary Principle suggests that these removal vectors should not be assumed and that the effects be considered permanent.

Vulnerability of the Proposed Project to Climate Change

High Wind Speeds

4.7.11 Damage to the Orbex PRIME Launch Vehicle may occur as a result of high wind loading. Launches may be delayed due to the suspension of ferry routes and flights. The Proposed Project is considered moderately sensitive to the effects of high wind speeds.

4.7.12 Met Office climate models anticipate that there will be a barely distinguishable change from baseline wind speed conditions between 2020 - 2078.

4.7.13 The annual average wind speed is predicted to be between 0-0.5 ms-1 lower than the 1981 - 2010 baseline levels. This minor decrease in wind speed can be considered a negligible impact of climate change. Although climate change is likely to result in a negligible decrease in wind speed for the northern Shetland Islands, extreme wind events will remain a risk to the Proposed Project site as the baseline annual mean wind speed for Unst is amongst the highest in the UK at 13.4 knots. Consequently, wind speed can be considered to pose a moderate adverse effect to the Proposed Project.

4.7.14 To mitigate against launch failure during extreme wind conditions, the weather needs to be closely monitored in the days preceding a launch and the launch delayed if wind speeds are deemed high enough to potentially cause damage to the Orbex PRIME Launch Vehicle, payload or on-site structures. Furthermore, to minimise the effect that transport route suspensions may have on launches, goods and services are sourced as close to the Proposed Project site as practicable. Following the implementation of these mitigation measures, the effect of strong winds on the Proposed Project can be considered minor adverse with no likely significant effect.

Heavy Precipitation

4.7.15 Increased incidences of extreme rainfall events may cause pluvial surface water flooding, which may impact upon operation of the Proposed Project. On-site roads and off-site access routes may experience erosion through scour caused by surface water flooding events. This may result in access restrictions for equipment and staff critical to the launch. In addition, electrical equipment may fail due to water ingress. Due to the potential for delay to launches, the receptors are deemed to be moderately sensitive to heavy rainfall events.

4.7.16 A slight increase in the annual average precipitation rate is expected from first launch until the late 2070s. Throughout both the 2020-2048 and 2050- 2078 periods, two thirds of scenarios predict a 0-10% increase in the annual average precipitation rate in Unst, compared to baseline levels. The projected slight increase in precipitation can be considered a minor adverse impact of climate change due to the low magnitude of change above baseline levels.

4.7.17 Due to the above factors, prior to the implementation of mitigation, pluvial flooding caused by heavy rainfall has the potential to have a moderate adverse impact on the Proposed Project.

4.7.18 SEPA's Climate Change Allowance for Flood Risk Assessment in Land Use Planning guidance advises that a 40% increase in rainwater drainage provision be applied to activities taking place in Shetland.

4.7.19 A drainage strategy and system has been designed by SaxaVord Spaceport to mitigate against localised surface water pooling and flooding, and the implementation of this strategy will reduce the potential effect of heavy rainfall on the operation of the Proposed Project to minor adverse with no likely significant effect.

High Temperatures

4.7.20 High temperatures may result in heatwaves and droughts, which may cause personnel welfare impacts (for example, heat stress), damage to machinery through overheating, and an increased risk of fire.

4.7.21 Throughout the climatic modelling window examined at the Proposed Project site, an increase in mean air temperature in northern Shetland is predicted. For the period 2020-2048, the annual mean air temperature in Unst is projected to be 1-2°C higher than the 1981-2010 average. This rises to 2-3°C above baseline levels for the 2050-2078 timescale, according to 75% of member scenarios.

4.7.22 Based on Met Office climate data from 1981 - 2001, temperatures in Unst are consistently low; the baseline maximum temperature is 15.2°C for August, compared to an average of 19.1°C across the UK. Extreme hot weather events occur infrequently and are of a low magnitude; the hottest temperature ever recorded at Baltasound was 25°C in July 1958. The predicted trend towards rising temperatures may increase the frequency of heatwaves and droughts in Unst. However, extreme temperatures are unlikely to be of a high enough magnitude to have a significant impact on the Proposed Project site, so this represents a minor climate change impact.

4.7.23 Considering the sensitivity of the receptor of human health and the potential for the magnitude of impact to rise throughout the design life of the Proposed Project, high temperatures have the potential to have a minor adverse effect.

4.7.24 Appropriate standard mitigation measures will be applied in the event of high temperature conditions during a launch event. Personnel will be provided with appropriate Personal Protective Equipment (PPE) to mitigate against the health and safety risks posed by heat and the availability of drinking water confirmed. Following the implementation of these measures, heat will pose a negligible risk to the Proposed Project and therefore result in no likely significant effect.

4.8 Residual Effects

4.8.1 No significant residual effects have been identified following the implementation of mitigation measures.

4.9 Cumulative Assessment

4.9.1 The climate resilience risks identified are limited in their spatial extent to the Proposed Project and therefore no cumulative effect with other committed developments is considered in this climate change impact assessment.

4.10 Summary

4.10.1 An assessment of the potential effects of greenhouse gas emissions associated with the Proposed Project on climate change has been undertaken.

4.10.2 The assessment considered emissions arising from the operation of the Proposed Project including transportation and combustion of Orbex PRIME Launch Vehicle fuel.

4.10.3 A climate resilience assessment has been carried out to assess the vulnerability of the Proposed Project to climate change.

4.10.4 The assessment evaluated the impact of climatic variables such as wind speed, precipitation and temperature on sensitive receptors associated with the Proposed Project.

4.10.5 The climate baseline has been characterised using Met Office climate data for the period 1981-2010.

4.10.6 Greenhouse gas emissions in the context of overall annual emissions from the Shetland Islands are considered of minor significance.

4.10.7 Mitigation measures including the investigation of non-fossil alkane substitutes and the continued decarbonisation of passenger and freight transport will contribute to reducing greenhouse gas emissions.

4.10.8 Climate resilience impacts on the Proposed Project associated with high temperatures are considered to be of negligible significance.

4.10.9 High wind speeds are predicted to have an effect of minor significance on the Proposed Project.

4.10.10 The effects of heavy precipitation on the Proposed Project are considered to be of minor significance.

4.10.11 Standard mitigation has been considered in the inference of effect significance. Committed mitigation measures include suspending activities during extreme weather events.

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Chapter 5 Ornithology

5. Ornithology

5. Ornithology

5.1 Introduction

5.1.1 This chapter considers the likely significant effects of the Proposed Project on birds; on-site, in the surrounding ornithological study area and further downrange within the environmental zone of influence (EZI). The assessment is based upon comprehensive baseline data collected for SaxaVord Spaceport, comprising specifically targeted ornithological surveys of potentially important and legally protected bird species identified during desk study and consultation feedback. It draws on pre-existing information, where appropriate, from other studies, survey data sources and relevant Chartered Institute for Ecology and Environmental Management (CIEEM) and NatureScot (previously Scottish Natural Heritage, SNH) guidance. The scope of the ornithological assessment excludes potential impacts on habitats, flora and other fauna, which are considered separately in Chapter 6: Ecology.

5.1.2 Alba Ecology Limited led on all aspects of the ornithological fieldwork and assessment in association with the Proposed Project. Alba Ecology is a Scottish-based multi-disciplinary ecological consultancy that has worked in the north of Scotland, and Shetland specifically, for many years. Alba Ecology's staff have led on and contributed to all aspects of Ecological Impact Assessment (EcIA) on several large-scale development projects and have undertaken the AEE for SaxaVord Spaceport and a number of other Launch Operators based at the same location. Their experience also includes management of Ecological Clerk of Works (ECoW) for major developments, principal ornithological/ecological surveyors and advisors on planning applications, expert witness advice at Public Local Inquiries and the production of Environmental Statements, Habitat Regulations Assessments and Habitat Management and Biodiversity Enhancement Plans.

5.1.3 The ornithological surveyors used between 2018 and 2024 were David Cooper, Brydon Thomason and Dr Peter Cosgrove. These surveyors have extensive ornithological field experience of Shetland and Unst specifically. Surveyors carried out bird surveys in a systematic and objective manner, following recognised standardised best practice methods. Those surveyors working near breeding birds listed in Schedule 1 of the Wildlife and Countryside Act 1981 (and as amended) were covered by relevant SNH Schedule 1 Bird Licences.

5.1.4 This chapter is supported by ornithological drawings from the 2021 Shetland Space Centre EIAR and the following Appendices in Volume IV:

- Appendix 5.1: (a) Shetland Space Centre Breeding Birds Survey Report and its addendum updates; (b) 'SaxaVord UK Spaceport Breeding Bird Survey, 2022', (c) 'SaxaVord UK Spaceport Breeding Bird Survey, 2023' and (d) 'SaxaVord UK Spaceport Breeding Bird Survey, 2024.

- Appendix 5.2: Background literature review of noise impacts on birds for the Shetland Space Centre (now SaxaVord Spaceport); and
- Appendix 5.3 SaxaVord Spaceport Habitat Management Plan.

5.1.5 Confidential bird species information, where information would have appeared in the relevant sections of this AEE Report chapter were it not for the fact that this information could endanger rare and legally protected species from wildlife crime, has been submitted to and assessed previously by the local planning authority, as part of the EIA process for SaxaVord Spaceport. This information is not included in the AEE submission as it does not make any material difference to the assessment findings; but, as required, has been shared with relevant statutory authorities during the planning process for SaxaVord Spaceport.

5.1.6 The assessment involved the following key phases:

- Reference to relevant legislation, policy and guidance.
- Identification of the appropriate ornithological study area and the likely EZI of the Proposed Project.
- Identification of potentially important ornithological receptors (baseline conditions) likely to be affected by the Proposed Project.
- Evaluation of important ornithological receptors and features likely to be affected by the Proposed Project.
- Identification of likely impacts and magnitude of the Proposed Project on important ornithological receptors; and
- Assessment of the likely significant effects of the Proposed Project, including any mitigation and enhancement measures and any residual significant effects.

5.1.7 The term 'receptor' is used throughout the AEE process and is defined as the element in the environment affected by a development (e.g., a bird in the case of ornithology). The term 'impact' is also used commonly throughout the AEE process and is defined as a change experienced by a receptor (this can be beneficial, neutral or adverse). The term 'effect' is defined as the consequences for the receptor of an impact.

5.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act 2018

5.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;

- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

5.2.2 As the Applicant wishes to become a spaceflight operator and launch Orbex PRIME Launch Vehicles from the UK, it is required to apply for a launch operator licence, and as part of this application, submit an AEE of the Proposed Project.

Space Industry Regulations 2021

5.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence and the Regulators Licensing rules, which specify what information the regulator, the UK Civil Aviation Authority (CAA), requires in support of an application.

Policy Context

5.2.4 Further relevant legislation and best practice guidance documents have been reviewed and taken into account as part of this ornithological assessment. The approach used to assess the significance of likely effects of the Proposed Project upon ornithological receptors is set in the context of:

- The Wildlife and Countryside Act 1981 (as amended);
- European Commission (EC) (2011) European Biodiversity Strategy;
- EC Directive 2009/147/EC on the conservation of wild birds (codified version). The so-called 'Birds Directive';
- EC Directive 1992/43/EEC on the conservation of natural habitats and of wild fauna and flora. The so-called 'Habitats Directive';
- The Conservation (Natural Habitats) Regulations 1994. The so-called 'Habitats Regulations';
- The Conservation of Habitats and Species Regulations 2010;
- The Nature Conservation (Scotland) Act 2004 (as amended);
- Scottish Government Planning Circular 1 2017: The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017;
- National Planning Framework 4 (NPF 4), 2022;
- The Scottish Biodiversity Strategy to 2045: Tackling the Nature Emergency in Scotland, 2024;
- Scottish Government Draft Planning Guidance: Biodiversity (2023);
- Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2016; 2018; 2019 as amended);
- Regional Population Estimates of Selected Scottish Breeding Birds (SNH, now NatureScot);

- Natural Heritage Zones Bird Population Estimates. SWBSG (Scottish Windfarm Bird Steering Group) Commissioned Report: 150413;
- Scottish Government. The Scottish Biodiversity List (SBL);
- Scottish Government 2020. The Environment Strategy for Scotland: vision and outcomes;
- Biodiversity Net Gain: Good practice principles for development: A practical guide. (CIRIA, CIEEM and IEMA 2019);
- Biodiversity Net Gain in Scotland, CIEEM Scotland Policy Group, 2019;
- Strategic Plan for Biodiversity 2011-2020. Convention on Biological Diversity;
- 'Living Shetland' – the Shetland Local Biodiversity Action Plan (LBAP);
- The Shetland Local Development Plan (2014); and
- The Shetland Local Development Plan – Natural Heritage Supplementary Guidance (2012).

5.2.5 There is no Scottish or UK specific ornithological guidance on launch operations.

5.2.6 The recently published Scottish Government's Draft Planning Guidance: Biodiversity sets out expectations for implementing and delivering National Planning Framework (NPF4) policies which support the cross-cutting NPF4 outcome 'improving biodiversity. NPF4 (2022) is designed to support Scotland's commitment of reaching net zero emissions and thereby tackling the climate change emergency.

5.2.7 The Scottish Biodiversity List (SBL) is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland, under the Nature Conservation (Scotland) Act 2004. The SBL therefore supersedes the UK Biodiversity Action Plan (BAP) list of species and habitats. Nevertheless, since most existing planning policy and guidance requires consideration of, and makes explicit reference to, UK BAP species and habitats, these are still referred to where necessary.

5.2.8 The Shetland Local Development Plan (2014) contains policies and objectives to conserve and enhance the habitats and species that contribute to the unique character and heritage of Shetland. It has links to Supplementary Guidance on Local Nature Conservation Sites in Shetland and Supplementary Guidance on Natural Heritage. This guidance is provided to aid planning applicants and their agents when considering development in relation to their biodiversity responsibilities.

5.2.9 It is recognised that the term 'Favourable Conservation Status' (FCS) as articulated within the EC Habitats Directive is not used in the EC Birds Directive, but SNH (now NatureScot) advises on its use and context in relation to consideration of birds. Conservation status is considered favourable where:

- Population dynamics indicate that the species is maintaining itself on a long-term basis as a viable component of its habitat.

- The natural range of the species is not being reduced, nor is it likely to be reduced in the foreseeable future.
- There is (and will continue to be) a sufficiently large habitat area to maintain its populations on a long-term basis.

5.2.10 Whilst considering a range of potential outcomes that could arise from the Proposed Project, the assessment reports the effects that are considered likely to be significant on the basis of evidence, standard guidance and professional judgement. It is these likely significant effects that the Applicant is obliged to report, and that the decision maker is obliged to consider.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

5.2.11 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note 'CAP 2215 Guidance for the Assessment of Environmental Effects' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

5.2.12 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including ecology and biodiversity.

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

5.2.13 The Department for Transport issued its document 'Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

5.2.14 The environmental objective for spaceflight is to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*

- *Protect people and wildlife from the impacts of noise from spaceflight activities; and*
- *Protect the marine environment from the impact of spaceflight activities.*

5.2.15 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE.

5.3 Consultation

5.3.1 Extensive statutory consultation on ornithological matters was carried out during preparation and determination of the planning application for SaxaVord Spaceport, from where the Proposed Project will operate. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application phase have been summarised in Table 5.1.

Table 5.1 – SaxaVord Spaceport Consultation responses directly relevant to this AEE

Consultee	Summary ornithology response	Where and how addressed
SNH (now NatureScot) - Jonathan Swale 16/02/18	Following an approach on 06/02/20 by Alan Farningham of Farningham Planning Ltd into the scope and scale of ornithological surveys, Jonathan Swale of SNH responded on 16/02/18 as follows: “The environmental assessment should consider the impacts on breeding birds of operation of the launch site, as well as its construction, so surveys should cover the area likely to be affected. Rocket launches could cause disturbance over a large area, but without information on the expected noise levels we aren’t able to advise on the likely extent of disturbance nor on the area that should be surveyed to carry out the impact assessment. It may be necessary to assess possible impacts on seabirds within Hermaness, Saxa Vord and Valla Field SPA but this will not require additional survey work as we have recent data that can be used”. Consideration of whimbrel within the Hill of Colvadale and Sobul SSSI was also recommended for potential works near that designated site. However, this	The nature and scale of the ornithological study area is discussed within this chapter and also Appendix 5.1. Breeding bird survey data collected by Alba Ecology is presented in Volume IV Appendix 5.1a-d. Consideration of potential noise impacts on birds is presented in Volume IV Appendix 5.2. Consideration of sensitive Schedule 1 species breeding information has been submitted to and assessed previously by the local planning authority, as part of the EIA process and is therefore not included in this AEE for reasons of confidentiality.

Consultee	Summary ornithology response	Where and how addressed
	area did not feature in the final planning Application Boundary, therefore is not reported on. SNH also advised that the cliffs around Lamba Ness were likely to support nesting fulmar, shag, black guillemot and possibly gulls and that these species should therefore be surveyed too.	
SNH - Glenn Tyler 24/05/20	Agreement on the proposed seabird (boat-based) survey methods and personnel was sought and agreed with Glenn Tyler at SNH (in a phone call on 24/05/18). Glen Tyler agreed that this approach was suitable and that three separate boat-based surveys spread across the first three weeks of June during suitable weather conditions was standard and 'sounded ideal', given the information available at the time. Surveys were undertaken in 2018 as per agreement with SNH.	Seabird survey data collected by Alba Ecology is presented in Appendix 5.1a-d.
SNH – 28/05/20	Alba Ecology provided SNH with a draft version of Appendix 5.1a.	Provided as part of a verbal agreement to share information/data ahead of the planning application submission.
SNH – 29/05/20 and 02/06/20	During data sharing with SNH it became apparent that SNH's existing bird data for the SPA (Special Protection Area) did not exist for the whole of the Hermaness, Saxa Vord and Valla Field SPA area. The SPA extends to Virdik but only the marine extension – it does not include the cliffs, which was the only section SNH monitors. Consequently, a gap in nesting seabird data for the area between Virdik and Ura was identified. On 02/06/20 SNH provided what up- to- date breeding bird data they had for the relevant designated sites.	Boat-based seabird surveys were conducted for the relevant 'gap' section of cliff in June 2020, which also coincided with the relaxation of COVID-19 restrictions for outdoor work. The same surveyors who undertook the 2018 boat-based seabird surveys conducted three boat-based seabird surveys between Virdik and Ura in June 2020 and have continued to do so, updating the ornithological baseline annually since then. (Note: Subsequently resurveyed in 2022, 2023 and 2024 with latest, up to date survey information presented as Appendix 5.1 b, c and d respectively.)

Consultee	Summary ornithology response	Where and how addressed
SNH – 18/08/20	Alba Ecology provided SNH with a brief update on the 2020 survey results and a draft of Appendix 5.2.	Information provided as part of a verbal agreement to share information/data ahead of the planning application submission.
Royal Society for the Protection of Birds (RSPB) Scotland – 28/05/20	Alba Ecology provided RSPB Scotland with a draft version of Appendix 5.1.	Provided as part of a verbal agreement to share information/data ahead of the planning application submission.
RSPB Scotland – 18/08/20	Alba Ecology provided RSPB Scotland with a brief update on the 2020 surveys and a draft of Appendix 5.2.	Information provided as part of a verbal agreement to share information/data.

5.3.2 Following consultation with NatureScot subsequent to submission of the planning application SaxaVord Spaceport, it has been confirmed by planning condition that no launches will be carried out between mid-May and the end of June in order to avoid disturbance to breeding birds during the critical incubation and early brooding period. The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.

5.3.3 The following potential impacts have been assessed in relation to the operation of the Proposed Project:

- Loss of foraging or breeding habitat due to displacement or avoidance.
- Death or injury of birds (including eggs and dependent young) through noise impacts associated with launches.
- Collison risk of birds striking Orbex PRIME Launch Vehicles during launches.

5.4 Assessment Methodology and Significance Criteria

Consultation

5.4.1 In accordance with CIEEM best practice guidance, consultation with SNH/NatureScot was undertaken throughout the planning process for SaxaVord Spaceport. As the Proposed Project environmental budget of ten launches per year makes up one third of that of the wider Spaceport; it was not considered necessary to undertake further consultation for this AEE.

Study Area and Environmental Zone of Influence (EZI)

5.4.2 The main elements of the Proposed Project which have the potential to impact on ornithological receptors during operation are described in Chapter 3 and include:

- Preparation of the Orbex PRIME Launch Vehicle;

- Storage and Handling of Launch Vehicle Propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of the Orbex PRIME Launch Vehicle.

5.4.3 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicle from Launch Pad 3 at SaxaVord Spaceport Lamba Ness Launch Site (LNLS) in Unst, Shetland.

5.4.4 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage expendable liquid fuelled launch vehicle primarily comprised of a carbon fibre structure. The fuel for both stages is Liquid Petroleum Gas (LPG), and Liquid Oxygen (LOX) as the oxidiser. Helium (He) is utilised on both stages for pressuring the fuel and oxidiser tanks.

5.4.5 The Orbex PRIME Launch Vehicle is designed to launch payloads of up to 180 kg into both sub-orbital trajectories and sun synchronous and polar orbits. The EZI for the Proposed Project is contained between 085 and 100 degrees from the equator. All launches will take place from Launch Pad 3 at SaxaVord Spaceport.

5.4.6 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport’s own assessed environmental budget of 30 launches per year.

5.4.7 Assessing the potential effects of disturbance on bird species is a complex issue which will vary depending on the type of disturbance (e.g., routine/predictable verses unusual/unexpected), topography, vegetation and the behaviour/tolerance of the bird species and even different individuals within species. Therefore, identifying a one-size-fits-all ornithological study area over which potentially affected breeding bird species should be surveyed is challenging. Consequently, this was considered in a number of different ways, which are outlined below.

5.4.8 In Scotland, all wild birds are legally protected, but some species are considered more sensitive to human related disturbance than others and they are specially protected under European, UK and Scottish legislation. Disturbance can have adverse effects on birds’ breeding success, e.g., through chilling, overheating and desiccation of eggs or chicks, predation and starvation of chicks and ultimately the abandonment of a breeding territory. Therefore, the distance over which disturbance might potentially occur was considered particularly important when determining the ornithological study area.

5.4.9 Limited work has taken place on the impact of disturbance on most of the bird species potentially present within habitats in Unst. However, for two of the important species which breed in Unst, some guidance has been published on the distances at which they are likely to be affected by human-related disturbance. In Ruddock and Whitfield (2007), 80% of experts canvased estimated static disturbance occurred at 500 m to 750 m for nesting and chick-rearing red-throated divers (Gavia stellata) and expert opinion suggested ‘safe working distances’ could exceed 500 m. Ruddock and

Whitfield (2007) suggested that breeding red-throated divers are sensitive to human activity, visual disturbance and sudden noise events over relatively large distances (e.g., up to 500 m). Evidence from Viking Wind Farm studies in Shetland indicated that some individual red-throated divers (perhaps habituated) appear to tolerate moderate levels of disturbance in some situations. The size of waterbodies also has an impact; breeding divers are more easily disturbed and fly from smaller nesting lochans (where they presumably feel more vulnerable) than larger nesting lochs, where they have the ability to swim away and dive underwater without taking flight.

5.4.10 Similarly, breeding merlins (Falco columbarius) are considered sensitive to human activity, visual disturbance and sudden noise events over large distances (e.g., up to 500 m) (Ruddock and Whitfield, 2007), particularly prior to egg laying and during incubation in Shetland (the late Mark Chapman, pers comm.). However, individual merlin pairs appear to tolerate moderate levels of disturbance in some situations. For example, merlins appear to be able to nest relatively close to public roads in Shetland, where regular (mostly predictable) disturbance occurs.

5.4.11 Based on Ruddock and Whitfield (2007), there is some limited evidence and expert opinion that sudden noise events up to 500 m to 750 m away from the two potentially affected bird species could be detrimental. Based on this, it might have been possible to recommend a one-kilometre survey buffer around the launch pads. However, none of the potentially affected target species had been monitored in relation to short-duration loud noise events of the magnitude of a launch. Furthermore, at the time of Pre-application consultation with SNH (2018) and determination of the ornithological study area, there was no information on predicted noise levels available. Consequently, this nominal one-kilometre survey buffer was not considered an adequate basis on which to determine the size of the ornithological study area.

5.4.12 During initial survey planning for the SaxaVord Spaceport planning phases, there was only an indicative boundary area for SaxaVord Spaceport. As a result, an arbitrary, but very large precautionary initial study area was selected for breeding bird surveys, based on bird species likely to be present from existing data sources e.g., Pennington *et al*. 2004 and the habitats present. According to expert opinion (Ruddock and Whitfield, 2007), the greatest distance any UK species was predicted to be affected by human induced disturbance was 1.5 – 2 km (for breeding golden eagle – which does not occur in Unst), and this was even considered by Ruddock and Whitfield to be overly precautious. Nevertheless, given the lack of any empirical evidence or guidance, it was decided that doubling the greatest possible disturbance distance for any UK breeding bird, i.e., a 4 km buffer from the Proposed Project, was a legitimate precautionary basis on which to proceed with breeding bird surveys to cover the potential zone of influence. Consequently, the size of the breeding bird study area (Drawing 5.1) was much larger than the final site boundary of SaxaVord Spaceport, and it was centred on indicative launch site locations provided by SaxaVord Spaceport during initial discussions in early 2018.

5.4.13 A plan of the breeding birds study area is included as Drawing 5.1.

Desk Study

5.4.14 An initial desk study was conducted in 2018 using the SNH's SiteLink website and Shetland Biological Records Centre data held for the study area. This was supplemented by existing knowledge of the breeding birds of Unst and consultation with SNH on the nature and scope of bird surveys. Given the time gap between 2018 and the planning submission, the exercise was repeated, using information from the same data providers as well as information from the National Biodiversity Network (NBN); a collaborative UK partnership created to exchange biodiversity information, in 2020. The information was compiled into a report and is presented in Appendix 5.1a.

5.4.15 The desk study identified several Annex 1, Schedule 1, UK BAP and SBL species previously recorded within the study area. Based on the results of the desk study, initial site-walkover, size/quality/importance of habitats present, EIA Scoping comments and feedback from the regulators, legal protection, the site and the exercise of professional judgement, the following potentially important ornithological receptors have been identified for further consideration:

- Nearby designated site species.
- Breeding red-throated diver.
- Breeding raptors, in particular merlin.
- Breeding waders, in particular whimbrel (*Numenius phaeopus*), curlew (*Numenius arquata*), ringed plover (*Charadrius hiaticula*), golden plover (*Pluvialis apricaria*) and dunlin (*Calidris alpina*).
- Breeding terns and skuas, in particular Arctic tern (*Sterna paradisaea*) and Arctic skua (*Stercorarius parasiticus*).
- Cliff nesting seabirds, in particular black guillemot (*Cepphus grylle*), common guillemot (*Uria aalge*), razorbill (*Alca torda*), puffin (*Fratercula arctica*), shag (*Phalacrocorax aristotelis*), fulmar (*Fulmarus glacialis*) and gulls.
- Potentially rare species, including confidential breeding Schedule 1 species.

5.4.16 There was no evidence from the desk study of the study area being especially important for non-breeding birds and SNH did not request non-breeding bird surveys. Consequently, for the planning application and in the subsequent period, surveys have focussed on breeding birds.

Site Visit

5.4.17 A reconnaissance site visit by Dr Peter Cosgrove in late autumn 2017 determined that the Proposed Project area was predominantly open coastal/upland habitat characterised by peatland, grassland and sea cliffs. The principal land use was sheep grazing through crofting and common grazing. There was potential for several specially protected bird species to be present, so breeding bird surveys were conducted under a SNH Schedule 1 licence.

Breeding Bird Surveys

5.4.18 Breeding bird surveys were undertaken monthly between April and July 2018 and 2019 within the ornithological study area (Appendix 5.1a). In 2020, additional Schedule 1 surveys were undertaken within the Proposed Project site boundary, to inform other surveyors working there of the potential avian sensitivities present through the production of an up-to-date Breeding Birds Protection Plan (BBPP) and associated on-site Ecological Clerk of Works (ECoW) support.

5.4.19 Updated and repeat breeding bird surveys for cliff nesting seabirds were undertaken in 2022, 2023 and 2024 and are provided as addendums to the original breeding bird survey report (Appendices 5.1b, c and d), providing updates to the original ornithological baseline and are summarised by table in the following breeding seabird accounts. The existing 2018-2020 survey data and assessment is considered robust in light of the updated 2022, 2023 and 2024 survey data (see summary below).

Moorland Breeding Bird Survey Methods

5.4.20 The modified Brown and Shepherd (1993) Moorland Breeding Bird survey is the standard survey technique for moorland/upland breeding birds (Gilbert *et al*., 1998) and is described in the SNH online guidance (e.g., SNH 2005; and subsequent updates). The main habitat was open moorland/grassland and so this survey technique was used across all parts of the study area. However, there were some wetter/marshy areas in the study area which were observed from the nearest edge. Further details are provided in Appendix 5.1a.

5.4.21 Population estimates of terrestrial birds in the study area were derived by comparing the summary maps for each of the breeding survey visits. Registrations/territories plotted during each period were considered to be separate from one another if more than approximately 500 m apart for larger species, 300 m in the case of smaller species. If there was any doubt about whether more than one pair of birds was present in an area, the surveyor would sit quietly nearby and observe the behaviour, gender and number of birds present as per Brown and Shepherd's (1993) survey methodology. When compiling figures of breeding birds, the approximate central location of all registrations recorded from different survey visits is used to identify a notional territory centre (the species 'dot' on the relevant drawing) where a nest was not discovered. Surveys were undertaken in 2018-2019 as per agreement with SNH across the study area and additionally in 2020, 2022, 2023 and 2024 for Schedule 1 species within the SaxaVord Spaceport boundary. Note, the SaxaVord Spaceport boundary is much smaller than the wider 4 km study area used in 2018-2019 and so subsequent 2020-2024 data is not comparable.

Breeding Raptor Survey Methods

5.4.22 SNH provides clear guidance in relation to raptor sensitivities and survey effort (2005; and subsequent updates). Breeding raptor surveys were undertaken to determine the location of any breeding merlins within the study area using standardised merlin survey methods (e.g., Hardey *et al*., 2013). These surveys also covered potential breeding habitats of kestrel and peregrine, were they to be present. Surveys were undertaken in 2018 and 2019 as per agreement with SNH across the study area and additionally in 2020, 2022, 2023 and 2024 for Schedule 1 species within the SaxaVord Spaceport boundary. Note, the SaxaVord Spaceport boundary is much smaller than the wider 4 km study area used in 2018-2019 and so subsequent 2020-2024 data is not comparable. Further details are provided in Appendix 5.1a-d.

Breeding Red-throated Diver Survey Methods

5.4.23 Following SNH standard guidance, searches for nesting red-throated divers were undertaken on all potentially suitable waterbodies within the study area. The waterbodies were visited at least twice during the breeding season if nothing was present. However, if the water body was occupied, sites were revisited later in the breeding season to determine nest locations and breeding success. Surveys were undertaken in 2018 and 2019 as per agreement with SNH across the study area and additionally in 2020, 2022, 2023 and 2024 within the SaxaVord Spaceport boundary. Note, the SaxaVord Spaceport boundary is much smaller than the wider 4 km study area used in 2018-2019 and so subsequent 2020-2024 data is not comparable. Further details are provided in Appendix 5.1a-d.

Black Guillemot

5.4.24 Counts of individual adult black guillemots provide the most accurate survey method for this species (Gilbert *et al*., 1998). Two survey visits, a week or more apart during the first three weeks of April were typically undertaken (when weather conditions allowed). The surveys were conducted from first light until particular defined potential black guillemot cliff reaches were surveyed, during suitable, calm and clear weather conditions (as per Gilbert *et al*., 1998). The surveyor, who was familiar with the study area, moved along the coast counting all black guillemots on the sea, within about 300 m of the shore and any that were on land. Repeat counts were also undertaken in the afternoon for some reaches for comparative purposes Surveys were undertaken in 2018 and 2019 as per agreement with SNH across the study area and additionally in 2020, 2022, 2023 and 2024. Further details are provided in Appendix 5.1a-d.

Cliff Nesting Seabirds

5.4.25 The standard method for surveying cliff nesting seabirds requires the number of individual adult birds per visit recorded or Apparently Occupied Nests (AON), which can either be summed and a mean produced over different survey visits undertaken or simply use the highest count to provide a maximum population estimate. The standard survey guidance recommends between two and five survey visits. Given the nature of the study area, with no low tide beach below the steep cliffs, boat-based counts were undertaken between the eastern edge of the Hermaness, Saxa Vord and Valla Field SPA (approximately Virdik) and The Nev (south-east of Hill of Clibberswick), as per agreement with SNH. No climbing down cliffs to count breeding seabirds was undertaken.

5.4.26 The razorbill, common guillemot and shag standard survey methods recommend surveys in the first three weeks of June in the north of Scotland in 'normal years' (June or July for gannets (Morus bassanus), June for fulmar, early-mid June for kittiwake (Rissa tridactyla). Consequently, boat-based surveys were scheduled for and undertaken during the first three weeks of June given the main species likely to be present on the cliffs (and where possible due to weather constraints, well-spaced across these three weeks). The two main sources of seabird survey guidance were followed: Gilbert *et al*., (1998) and JNCC Seabird Monitoring Handbook (Walsh *et al*., 2011).

5.4.27 Puffins are difficult to census due to their use of burrows, often in inaccessible locations. The most reliable way in which they are monitored is by long-term monitoring of Apparently Occupied Burrows (AOB) from sample areas, rarely possible in Shetland due to the steep and inaccessible nature of much of the terrain (Mitchell *et al*., 2004). When these burrows cannot be accessed, as was the case within the study area, the standard survey methodology is to count individual birds on land, which provides a rough estimate of numbers present. However, in Shetland such previous counts have mostly taken place at the same time as the optimal count for other cliff nesting seabirds in June, when it is known that nonbreeding puffins also attend colonies and so can inflate numbers of presumed breeders present. This is a recognised limitation of the survey method in Shetland and needs to be recognised when comparing puffin data from other/previous surveys.

5.4.28 Further methodological detail on how each seabird species was counted is provided within the JNCC Seabird Monitoring Handbook (Walsh *et al*., 2011). These survey methods and proposed personnel were discussed and agreed with Glenn Tyler at SNH (in a phone call on 24/05/18; Table 5.1). Surveys were undertaken as per agreement with SNH. Further details are provided in Appendix 5.1a-d.

5.4.29 During data sharing with SNH in 2020 it became apparent that existing bird data for the SPA did not exist for the whole of the Hermaness, Saxa Vord and Valla Field SPA area. The SPA extends to Virdik but only the marine extension – it does not include the cliffs, which is the only section SNH monitors. Consequently, a gap in cliff nesting seabird data for the area between Virdik and Ura was identified. Fortuitously, this data gap was identified in May 2020, allowing boat-based seabird surveys to be organised for the relevant section of cliff in June 2020. The same experienced surveyors who undertook the 2018 boat-based seabird surveys conducted the 2020 (and also 2022, 2023 and 2024) boat-based seabird surveys between Virdik and Ura, providing consistency of experienced observers.

Assessment of Potential Effect significance

5.4.30 This section defines the criteria used to evaluate the likely significance of predicted effects on important ornithological receptors due to the Proposed Project. A level of confidence (whether the predicted effect is certain, likely, possible or unlikely) is attached to the predicted effect.

Evaluating Conservation Importance

5.4.31 The ornithological receptors identified in the baseline studies have been evaluated following best practice guidelines (e.g., CIEEM, 2018 and SNH/NatureScot guidance). Identifying the importance of potential ornithological receptors was the first step of the process, and those considered potentially important, and present were then subject to detailed survey and assessment. Those considered sufficiently widespread, unthreatened, and resilient to the project impacts have been scoped out of further assessment as per best practice EcIA guidance (e.g., CIEEM, 2018).

5.4.32 Ornithological receptors can be important for a variety of reasons and the rationale used to define their importance has been explained to demonstrate a robust selection and evaluation process. Importance may relate, for example, to a designated site, to species rarity, to the extent to which they are threatened throughout their range, or to their rate of decline. Various characteristics contribute to the potential importance of ornithological receptors within a study area. Examples include:

- Naturalness of a bird population.
- Species, sub-species or varieties that are rare or uncommon, either internationally, nationally or more locally, including those that may be seasonally transient.
- Ecosystems and their component parts, which provide the habitats required by important bird species, populations and/or assemblages.
- Endemic bird species or locally distinct sub-populations of a species.
- Size of a bird population.
- Bird species in decline.
- Large populations of bird species or concentrations of species considered uncommon or threatened in a wider context.
- Bird species on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change.

5.4.33 Guidance on EcIA sets out categories of ornithological or nature conservation importance that relate to a geographical framework (e.g., international through to local) together with criteria and examples of how to place a site or study area (defined by its ornithological attributes) into these categories. It is generally straightforward to evaluate sites or species populations designated for their international or national importance (as criteria for defining these exist e.g., SPA and SSSI), but for sites or populations of regional or local importance, criteria may not be easily defined.

5.4.34 According to CIEEM EcIA guidance (2018) the importance of an ecological feature should be considered within a defined geographical context, and these should be adapted to suit local circumstances, as outlined in Table 5.2.

Table 5.2 – Summary of Geographic Population Importance Criteria Used

Term	Use
International	For example, >1% of European Community (EC) population, internationally designed site feature.
National	For example, >1% of United Kingdom (UK) or Scottish population, nationally designated site feature.
Regional	For example, >1% of the relevant Natural Heritage Zone (NHZ) population, regionally designed site feature.
Local	For example, within local area (<1% of relevant NHZ population), local wildlife sites.

5.4.35 There is no fundamental biological reason to take 1% of a population as the threshold level for establishing the level of geographic importance of a site. Nevertheless, this percentage is widely considered to be of value in developing measures that give an appropriate level of protection to populations and has gained acceptance on this basis throughout the world. The criterion was, for example, adopted by parties involved in the Ramsar Convention 1971. Thereafter, the 1% level of national species totals has been taken as the basis of assessment in various countries, including Britain (Stroud *et al*., 1990).

5.4.36 For breeding bird species, SNH/NatureScot uses the NHZ (Natural Heritage Zone) as the appropriate regional biogeographical unit of assessment. 21 zones covering Scotland have been drawn to reflect biogeographical differences between zones, with a high level of coherence within each zone. According to SNH guidance '*the question as to whether there is an impact on a [bird] species regionally therefore may be translated into the question as to whether there is an impact within the relevant NHZ*'. The Proposed Project is wholly within the Shetland NHZ and so this biogeographical unit is used for the regional population assessment.

5.4.37 The Scottish Wind Farm Bird Steering Group published a systematic review of NHZ bird populations across Scotland, including Shetland (Wilson *et al*., 2015), which is helpful in the context of determining regional bird population estimates. The Viking Wind Farm Environmental Statement also examined existing data sources and estimated relevant Shetland bird populations (Viking Energy Partnership, 2009) and provides useful additional information on Shetland priority bird population estimates. The regional population metrics reported in this chapter are mostly derived from the Scottish Wind Farm Bird Steering Group report and those used in the Viking Wind Farm ES and have been updated where more up to date population data/information was available.

5.4.38 The importance attached to an ecological receptor can also be determined according to legislative status. Some ecological receptors are subject to a general level of legal protection through e.g., the Wildlife and Countryside Act 1981 (as amended), or The Nature Conservation (Scotland) Act 2004 (as amended) and others under the Birds

Directive. There is no clear guidance for conservation importance of ecological receptors other than those of European Protected Species and designated sites. The importance of other species and habitats is based on professional judgement using the characteristics outlined above. The status of potentially important receptors, such as being on the SBL, is also taken into consideration.

5.4.39 Nevertheless, and for the avoidance of doubt, CIEEM EcIA guidance (2018) makes it clear that species which appear on national lists e.g., Schedule 1 of the Wildlife and Countryside Act (1981 as amended) and SBL are not necessarily evaluated as of national importance simply by appearing on such a 'national' list. Importance evaluation must consider the number of individuals of species or area of habitat within a geographical context/scale, i.e., how many of a particular species are likely to be affected by the Proposed Project and what proportion of the local/regional/national population does this constitute. Legal listing/protection is a separate but important consideration.

Extent

5.4.40 According to CIEEM (2018) EcIA guidance, extent is the spatial or geographical area over which the predicted impact/effect may occur under a suitably representative range of conditions.

Magnitude

5.4.41 According to CIEEM (2018) EcIA guidance, magnitude refers to size, amount, intensity and volume. It should be quantified if possible and expressed in absolute or relative terms e.g., the amount of habitat lost, number of pairs lost, percentage decline in a species population. For consistency across all the topics within the AEE, magnitude terms are required and are clearly defined (Table 5.3), along with metrics in absolute and relative terms. There are a number of approaches for determining the significance of effects on ecological features. This includes methods for scoring and ranking impacts on the basis of subjective criteria. Results are often presented in the form of a matrix in which ecological value/importance and magnitude of impact are combined into a significance score. A matrix approach is commonly used in EIA by disciplines other than ecology to assign significant residual effects to categories (e.g., major, moderate, minor). CIEEM (2018) guidance discourages use of the matrix approach and artificial significance scores. Spurious assessment should be avoided in which artificial numerical scores, or significance rankings/categories are used without a clear definition of the criteria and thresholds that underpin them.

Table 5.3 – Summary of Magnitude Criteria Used

Term	Definition
Major	Total/near total loss of a population due to mortality or displacement. Total/near total loss of breeding productivity in a population due to disturbance. e.g., ≥50% of population affected.

Term	Definition
Moderate	Moderate reduction in the status or productivity of a population due to mortality or displacement or disturbance. e.g., 10-49% of population affected.
Minor	Small but discernible reduction in the status or productivity of a population due to mortality or displacement or disturbance. e.g., 1-9% of population affected.
Negligible	Very slight reduction in the status or productivity of a population due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the 'no change' situation. e.g., <1% population affected.

Duration

5.4.42 According to CIEEM (2018) EcIA guidance, duration should be defined in relation to ornithological characteristics (such as the life cycle of a species). The duration of an activity may differ from the duration of the resulting effect caused by the activity. Impacts and effects may be described as short, medium or long-term and permanent or temporary and should be defined. In this assessment three timeframes are used: short-term (up to two years), medium-term (two-five years) and long-term (between five years and the lifetime of the Proposed Project).

Frequency and Timing

5.4.43 According to CIEEM (2018) EcIA guidance, the number of times an activity occurs will influence the resulting effect. For example, a single person walking a dog will likely have very limited impact on nearby wader utilisation of a wetland, but numerous dog walkers will subject the waders to frequent disturbance and could affect feeding success, leading to displacement of the birds and knock-on effects on their ability to survive. The timing of an activity may result in an impact if it coincides with critical life-stages or seasons e.g., bird nesting season.

Reversibility

5.4.44 According to CIEEM (2018) EcIA guidance, an irreversible effect is one from which recovery is not possible within a reasonable timescale or there is no reasonable chance of action being taken to reverse it. A reversible effect is one from which spontaneous recovery is possible or which may be counteracted by mitigation. In some cases, the same activity can cause both reversible and irreversible effects.

Sensitivity

5.4.45 Another factor when assessing potential impacts is the sensitivity of the ornithological receptor under consideration (e.g., high, medium or low), which can vary in space and time. Different receptors respond differently to stimuli, making some particularly sensitive to development activities and others less so. Professional judgement is used when assigning a sensitivity value to an ornithological receptor and this is recorded in a clear and transparent way.

5.4.46 By way of example, sensitivity is determined according to species behaviour, using broad criteria set out in Table 5.4. Behavioural sensitivity can differ between species and between individuals of the same species. Therefore, sensitivity is likely to vary with both the nature and context of the disturbance activity as well as the experience and even personality of the individual bird. Sensitivity also depends on the activity the species is undertaking. For example, a species is likely to be less tolerant of disturbance close to its nest during the breeding season than at other times of year. Furthermore, breeding birds are widely considered to be more likely to abandon eggs rather than dependent young, which they may have developed familial ties to. Thus, sensitivity changes with both space and time.

Table 5.4 – Summary of Sensitivity Criteria Used

Term	Definition
High	Species occupying remote areas away from human activities and exhibiting strong and long-lasting reactions to disturbance events.
Medium	Species that appear to be warily tolerant of human activities and exhibiting short-term reactions to disturbance events.
Low	Species occupying areas subject to frequent human activity and exhibiting mild and brief reaction to disturbance events.

Ecosystem Services

5.4.47 Ecosystem services are the benefits that people derive from the natural environment. The natural environment can be considered a stock of ‘natural capital’ from which many benefits flow e.g., social, health-related, cultural or economic (CIEEM, 2018).

Criteria for Evaluating Significance

5.4.48 Significance is a concept related to the weight that should be attached to predicted effects when decisions are made. A ‘significant effect’ is an effect that either supports or undermines biodiversity conservation objectives for important receptors (CIEEM, 2018). There could be any number of possible impacts on important ornithological features arising from a development. However, it is only necessary to describe in detail the impacts that are considered likely to be significant. Impacts that are either unlikely to occur, or if they did occur are unlikely to be significant, can be scoped out.

5.4.49 In this assessment, a significant effect is defined as ‘an impact on the integrity of a defined site or ecosystem and/or the conservation status of habitats or species within a defined geographical area’. Thus, the geographical terms of reference at which a predicted effect may be considered significant must also be defined (e.g., an effect on a species population evaluated to be of regional importance at a given site is likely to be either significant or not at the regional level). Effects can be considered significant at a wide range of scales from international to local.

5.4.50 There is sometimes confusion over geographical context, potentially important receptors and quantifying predicted effects and EcIA best practice guidance has struggled to articulate this clearly. For example, if a potentially important species appears on a conservation list e.g., the SBL and there is a predicted impact, the geographical context in which the receptor is found must be considered (CIEEM, 2018). Therefore, the simple presence of a species on the SBL within an area does not mean that likely effects are significant at the national (Scottish) level. For that to occur a Proposed Project must have likely significant effects on its national (Scottish) population.

Requirements for Mitigation

5.4.51 Best practice guidance e.g., CIEEM (2018) and recently NPF4 identifies a hierarchy of mitigation for potential impacts that seeks to:

- Avoid and prevent adverse ecological impacts, especially those that would likely be significant to important receptors.
- Minimise and reduce adverse impacts that cannot be avoided.
- Compensate and offset for any remaining likely significant residual impacts.

5.4.52 CIEEM EcIA guidance (2018) states that '*Avoiding and/or minimising negative impacts is best achieved through consideration of potential impacts of a project from the earliest stages of scheme design and throughout its development*'. This approach to avoiding potential adverse impacts within a design layout is sometimes described as embedded mitigation or mitigation by design. *'Mitigation by design is particularly beneficial as there is greater certainty that it will be delivered'* (CIEEM 2018).

5.4.53 This AEE Report chapter considers mitigation in the context of CIEEM guidance and also in relation to local planning authority guidance for protected species. The embedded mitigation is considered in the design layout and because of this, it is guaranteed through planning conditions for the Proposed Project. Where likely significant effects are predicted regardless of design layout, further mitigation is separately identified as per CIEEM best practice guidance.

Assessment of Residual Effect Significance

5.4.54 After assessing the potential impacts of the Proposed Project (incorporating embedded mitigation), all feasible attempts have been made to further avoid and mitigate predicted adverse ornithological impacts. Once measures to avoid and mitigate predicted ornithological impacts had been incorporated, assessment of the residual impacts was undertaken to determine the likely significance of their effects on important ornithological features.

Limitations to Assessment

5.4.55 Where assumptions within the assessment are made, these are explicitly identified and explained. Similarly, limitations in methods and knowledge of species' ecology are also identified and discussed, particularly where this is likely to affect the outcome of the assessment. As with any environmental assessment there will be elements of uncertainty. Where there is uncertainty, this is identified and reported transparently, along, where possible, with the measures taken to reduce it, assumptions made, and an explanation as to the likely extent that any uncertainties are likely to affect the assessment conclusions. In circumstances where there is uncertainty; evidence, expert opinion, best practice guidance and professional judgement have been used to evaluate what is considered biologically likely to occur if the Proposed Project is operational.

5.4.56 The level of certainty of impact prediction varies depending upon a range of parameters discussed already. For some elements e.g., land-take it is relatively straightforward to assess and quantify the area of habitat that is likely to be lost to development infrastructure and therefore quantify potential impacts of land-take on the habitats and species present. The main limitations in this assessment are common to most ornithological assessments because:

- Baseline surveys undertaken are based on sampling techniques, not absolute censuses. Results give an indication of the numbers of ornithological receptors recorded at the particular times that surveys were carried out (e.g., 2018, 2019, 2020, 2022, 2023 and 2024 for breeding bird surveys). Species occurrence changes over time and therefore the results presented in this AEE Report are snapshots in time.
- Putting ornithological survey results into a wider geographical context is sometimes challenging because some species have not been systematically surveyed beyond the study area. Thus, defining a receptor population as locally or regionally important is potentially difficult because local or regional population estimates do not exist for many taxa. Whenever such uncertainty exists, professional judgement and published evidence is used and populations in the study area or site have been assumed to be at their highest potential level of geographical/ ornithological importance.

5.5 Baseline Conditions

Designated Sites

5.5.1 The 2020 desk study identified three designated sites (which overlap) where birds were a qualifying feature within the 4 km ornithological study area (Drawing 5.2). There have been no changes to designated sites within the study area in the subsequent period. The identified sites are detailed below.

Hermaness, Saxa Vord and Valla field SPA (6,833 ha)

5.5.2 According to SNH/NatureScot (https://sitelink.nature.scot/site/8512) 'The Hermaness, Saxa Vord and Valla Field SPA lies in the north-west corner of the island of Unst, Shetland, at the northernmost tip of Britain. It consists of 100-200 m high sea cliffs and adjoining areas of grassland, heath and blanket bog. The boundary of the SPA is coincident with that of the Hermaness SSSI, Saxa Vord SSSI, and Valla Field SSSI. The seaward extension extends approximately 2 km into the marine environment to include the seabed, water column and surface.

5.5.3 Hermaness, Saxa Vord and Valla Field SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex I species red-throated diver (average of 26 proven breeding pairs for 1994 - 1999, 3% of the British breeding population). It also qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species; gannet (16,400 pairs in 1999, 8% of the British and 6% of the world population), great skua (788 pairs in 1997, 9% of the British and 6% of the world population) and puffin (55,000 individuals in 1999, 6% of the British and 3% of the total population of the sub-species *F. a. grabae*).

5.5.4 The Hermaness, Saxa Vord and Valla Field SPA qualifies further under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. It regularly supports 157,500 seabirds including nationally important populations of the following species: fulmar (19,539 pairs in 1999; 4% of the British population), shag (450 pairs in censuses in 1995 and 1999; 1% of the British population), common guillemot (25,000 individuals over two surveys carried out in 1996 and 1999; 2% of the British population) and kittiwake (922 pairs in 1999; 0.2% of the British population)'.

Hermaness SSSI (978 ha)

5.5.5 According to SNH/NatureScot (https://sitelink.nature.scot/site/776) 'The high cliffs and stacks of the west and north support large colonies of nesting seabirds. A range of species occur in various nesting habitats including kittiwake on bare cliff ledges, herring gull and great black-backed gull on the summits of stacks and on sloping coastal rocks, shag and razorbill among cliff-foot boulders and black guillemot in rock crevices.

5.5.6 Some species individually reach numbers of national importance. These include gannet at 6% of the British population, puffin (4%), fulmar (3%) and guillemot (1%). Inland from the cliffs, the bog and heath vegetation provide nesting habitat for one of the largest colonies of great skua in the world, representing over 3% of the global population'. Hermaness SSSI is part of Hermaness, Saxa Vord and Valla Field SPA.

Saxa Vord SSSI (55.47 ha)

5.5.7 According to SNH/NatureScot (https://sitelink.nature.scot/site/475) 'The site is located on the coastline to the east of Saxa Vord hill overlooking Burra Firth and extends from Grisa Lee in the south to The Noup in the north. At the Noup the site boundary includes both sides of the headland and extends down the east coast to Ura. The site also contains several skerries which along with the sea cliffs support a wide range of seabirds. The site is notified for its nationally and internationally important breeding fulmar and guillemot populations and for the seabird colony as a whole.

5.5.8 The site supports a breeding colony of fulmar and guillemot contributing to 1.2% and 0.4% of the British population respectively'.

5.5.9 Beyond the 4 km Ornithological Study Area there are other designated sites, some with ornithological features. Table 6.6 within AEE Report Chapter 6, Ecology, outlines biological designated sites within 10 km of the Proposed Project and includes the recently designated Fetlar to Haroldswick Marine Protection Area.

Ornithological Receptors

5.5.10 A summary of the principal findings from three years of targeted ornithological surveys (2018-2020) are provided below. Repeat breeding bird surveys were undertaken in 2022, 2023 and 2024 for cliff nesting seabirds and findings are provided as addendums to the original breeding bird survey report, providing updates to the ornithological baseline (Appendix 5.1). No new regular breeding bird species were recorded in 2022, 2023 or 2024.

5.5.11 The study area was surveyed under SNH Schedule 1 licence for breeding birds in 2018 and 2019 by Mr David Cooper. Mr David Cooper and Mr Brydon Thomason undertook boat-based seabird counts. In 2020 Mr David Cooper surveyed the SaxaVord Spaceport site during the breeding season to inform summer survey visits by staff and other non-ornithological surveyors e.g., archaeologists. Both Mr David Cooper and Mr Brydon Thomason are highly experienced and competent, locally based ornithologists and used the relevant standard breeding bird survey methods during suitable weather conditions.

5.5.12 A total of 135 bird species were recorded in the study area during targeted breeding bird surveys. For full list of species recorded see Appendix 5.1. There is direct evidence from the study area surveys of potentially sensitive and specially protected bird species breeding within, and adjacent to, the Proposed Project and so these need to be considered further. These birds were considered 'wider countryside species' for the purposes of evaluation and do not form part of any designated site feature.

5.5.13 The accompanying drawings provided for important ornithological receptors have been drawn showing distance bands away from the most westerly pad (Pad 1) with the following increments illustrated: 0-0.5 km; 0.5-1 km; 1-2 km; 2-3 km and 3-4 km. The Orbex PRIME Launch Vehicle will be launched from Pad 3, which is slightly to the east of Pad 1 and is further away from almost all ornithological receptors.

Red-throated Diver

5.5.14 Evidence of breeding from three lochans within the study area. Two breeding attempts in study area in 2018 – one failed and one presumed failed. Two breeding attempts in study area in 2019, both presumed successful as near-fledged juveniles seen at both sites. Further confidential details were provided to the local planning authority for assessment during the planning application phase of the SaxaVord Spaceport in accordance with SNH (2016) guidance. Red-throated divers continued to breed in the two regularly used study area sites between 2020 and 2024.

Black Guillemot

5.5.15 The maximum count in 2018 was 84 black guillemots with 101 in 2019. The black guillemot surveys counted individual adult birds. The locations of breeding black guillemots are from the original EIAR are presented in Drawing 5.3. The maximum number of breeding black guillemots between 2018-2024 is summarised in Table 5.5.

Table 5.5 – Maximum number of black guillemots, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Black guillemot	84 adults	101 adults	93 adults	107 adults	130 adults

Shag

5.5.16 The maximum boat-based count was 55 shag AON in 2018. The addition of a maximum 26 AON in the area between Virdik and Ura in 2020, provides an overall total of 81 shag AON within the 4 km study area (between Ura and The Nev). The locations of breeding shags from the original EIAR are presented in Drawing 5.4. The maximum number of breeding shags between 2018-2024 is summarised in Table 5.6.

Table 5.6 – Maximum number of shag nests, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Shag	55 nests	26 nests	32 nests	42 nests	47 nests

Gannet

5.5.17 For clarity, no breeding gannets were recorded on boat-based surveys between 2018 and 2024.

Fulmar

5.5.18 The maximum boat-based count was 4,300 fulmar Apparently Occupied Nest (AON) in 2018. The addition of 2,657 AON in the area between Virdik and Ura in 2020, provides an overall total of 6,987 fulmar AON within the 4 km study area (between Ura and The Nev). The locations of breeding fulmar from the original EIAR are presented in Drawing 5.5. The maximum number of breeding fulmars between 2018-2024 is summarised in Table 5.7.

Table 5.7 – Maximum number of fulmar AON, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Fulmar	4,330 AON	2,657 AON	3,416 AON	3,188 AON	3,868 AON

Kittiwake

5.5.19 The maximum boat-based count was 55 kittiwake AON in 2018. The addition of no kittiwake AON in the area between Virdik and Ura in 2020, provides an overall total of 55 kittiwake AON within the 4 km study area (between Ura and The Nev). The locations of breeding kittiwake from the original Environmental Impact Assessment Report (EIAR) are presented in Drawing 5.6. The maximum number of breeding kittiwake between 2018-2024 is summarised in Table 5.8.

Table 5.8 – Maximum number of kittiwake, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Kittiwake	55 nests	0 nests	123 nests	114 nests	110 nests

Black-headed Gull

5.5.20 A small black-headed gull (*Chroicocephalus ridibundus*) colony consisting of 11 pairs (2018) and 13 pairs (2019) was present at the Norwick Meadows (Drawing 5.6).

Common Gull

5.5.21 A moderate number of common gulls (*Larus canus*) bred, consisting of 22 pairs (2018) and 30 pairs (2019) at Braefield in a mixed gull colony (Drawing 5.6).

Lesser Black-backed Gull

5.5.22 A small number of lesser black-backed gulls (Larus fuscus) bred, consisting of 12 pairs (2018) and 10 pairs (2019) at Braefield in a mixed gull colony (Drawing 5.6). A very small number of lesser black-backed gulls were recorded breeding on cliffs in 2023 and 2024 (Table 5.9).

Table 5.9 – Maximum number of lesser black-backed gulls, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Lesser black-backed gulls	0 nests	0 nests	0 nests	3 nests	1 nest

Great Black-backed Gull

5.5.23 The maximum boat-based count was two great black-backed gull (*Larus marinus*) AON in 2018. The addition of a maximum six AON in the area between Virdik and Ura in 2020, provides an overall total of eight great black-backed gull AON within the 4 km study area (between Ura and The Nev). The locations of breeding great black-backed gull from the original EIAR are presented in Drawing 5.6. The maximum number of breeding great black-backed gull between 2018-2024 is summarised in Table 5.10.

Table 5.10 – Maximum number of great black-backed gulls, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Great black-backed gulls	2 nests	6 nests	14 nests	10 nests	9 nests

Herring Gull

5.5.24 There was no herring gull (*Larus argentatus*) AON recorded in 2018. The addition of five AON in the area between Virdik and Ura in 2020, provides an overall total of five herring gull AON within the 4 km study area (between Ura and The Nev). Up to 16 pairs also bred in land at Braefield in a mixed gull colony, within the 3-4 km distance band. The locations of breeding herring gull from the original EIAR are presented in Drawing 5.6. The maximum number of breeding herring gull between 2018-2024 is summarised in Table 5.11.

Table 5.11 – Maximum number of herring gulls, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Herring gull	0 nests	5 nests	19 nests	20 nests	14 nests

Common Guillemot

5.5.25 The maximum boat-based count was 80 individual common guillemots in 2018. The addition 20 individuals in the area between Virdik and Ura in 2020 provides an overall total of 100 individual common guillemots within the 4 km study area (between Ura and The Nev). The locations of breeding common guillemot from the original EIAR are presented in Drawing 5.7. The maximum number of breeding common guillemot between 2018-2024 is summarised in Table 5.12.

Table 5.12 – Maximum number of common guillemot, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Common guillemot	80 birds	20 birds	102 birds	187 birds	68 birds

Razorbill

5.5.26 The maximum boat-based count was 11 individual razorbills in 2018. The addition of four individuals in the area between Virdik and Ura in 2020, provides an overall total of 15 individual razorbills within the 4 km study area (between Ura and The Nev). The locations of breeding razorbill from the original EIAR are presented in Drawing 5.8. The maximum number of breeding razorbill between 2018-2024 is summarised in Table 5.13.

Table 5.13 – Maximum number of razorbill, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Razorbill	11 birds	4 birds	20 birds	24 birds	6 birds

Puffin

5.5.27 The maximum boat-based count was 49 individual puffins in 2018. The addition of 76 individuals in the area between Virdik and Ura in 2020, provides an overall total of 125 individual puffins. The locations of breeding puffin from the original EIAR are presented in Drawing 5.9. The maximum number of breeding puffin between 2018-2024 is summarised in Table 5.14.

Table 5.14 – Maximum number of puffin, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Puffin	49 birds	41 birds	115 birds	150 birds	151 birds

Merlin

5.5.28 Evidence of successful breeding near to, but not within the study area. One nearby successful breeding attempt in 2018 - a brood of three fledged merlin recorded around Northdale. Despite searching, no merlin nest was recorded within the study area, and it is not known where the fledged brood came from. One nearby successful breeding attempt in 2019. A female with fledged juveniles was recorded around between Skaw and Inner Skaw. Despite careful searching, no merlin nest was recorded within the study area, and it is not known where the fledged brood came from. Whilst it is assumed, they came from close to the study area boundary, it is possible they may have come from further away.

Ringed Plover

5.5.29 Evidence of multiple pairs breeding in study area. Nine breeding pairs were recorded in 2018 and 10 breeding pairs recorded in 2019 (Drawing 5.10). Most of the pairs were found at Skaw, Lamba Ness and Norwick, including pairs within the Proposed Project boundary (Drawing 5.11).

Golden Plover

5.5.30 Evidence of multiple pairs breeding in study area. Seven breeding pairs were recorded in 2018 and 13 pairs in 2019 in the study area (Drawing 5.12). Breeding pairs were distributed throughout the study area including at Saxa Vord, Sothers Field, Northdale, Housi Field, Hill of Clibberswick and Swartling, including one pair within the Proposed Project boundary (Drawing 5.13).

Whimbrel

5.5.31 Evidence of multiple pairs breeding in study area. There were five breeding territories in 2018 and four in 2019. Further confidential details were provided to the local planning authority for assessment during the planning application phase of the SaxaVord Spaceport in accordance with SNH (2016) guidance.

Curlew

5.5.32 Evidence of multiple pairs breeding in study area. There were ca. 16 breeding territories in 2018 and ca. 13 in 2019 (Drawing 5.14). Given the distances breeding curlews can move, it is possible that some territories have been double-counted and without colour ringing it is not possible to be certain. Nevertheless, in areas where multiple curlew territories have been plotted close together e.g., Norwick Meadows, there was direct evidence of multiple pairs being present within a relatively small area, including pairs within the SaxaVord Spaceport Planning Application boundary (Drawing 5.15).

Dunlin

5.5.33 Evidence of multiple pairs breeding in study area (Drawing 5.16). Five breeding territories were recorded in 2018 and four breeding territories recorded in 2019. Breeding territories were located in areas including Saxa Vord hill, Southers Field, Skaw, Lamba Ness and Housi Field, including one pair within the Proposed Project boundary (Drawing 5.17).

Arctic Tern

5.5.34 Evidence of multiple pairs breeding in study area (Drawing 5.18). A few small breeding colonies were present within the study area, with one pair on Hill of Clibberswick in 2018, two pairs in 2018 and three pairs in 2019 on Norwick beach and six pairs in 2018 and 10 pairs in 2019 at Skaw.

Arctic Skua

5.5.35 Evidence of multiple pairs breeding in study area. Five pairs of Arctic skua recorded breeding in the study area in 2018 and 2019 (Drawing 5.19). Pairs occupied territories both years in areas such as Hill of Clibberswick, Ward of Norwick and Inner Skaw, including territories very close to the Proposed Project boundary (Drawing 5.20).

Great Skua

5.5.36 Highly variable numbers of great skua (Stercorarius skua) were recorded during surveys, reflecting the social nature of this species. Large numbers of non-breeding great skuas can hold territory in apparently suitable breeding habitats, making accurate estimates of actual number breeding difficult and with a high degree of uncertainty. It is considered the numbers of breeding pairs within the study area likely to be in the low tens, with breeding birds mainly concentrated over three kilometres away from the nearest launch pad. Great skua numbers were concentrated around Saxa Vord hill e.g., with minimum 17 nests recorded in June 2018 and groups of presumed non-breeders numbering up to 90 individuals. Additionally, within the 3 km to 4 km buffer, smaller numbers of great skua were recorded at Sothers Field and Housi Field (Drawing 5.21).

Confidential Schedule 1 Species

5.5.37 Confidential species information, where information would have appeared in the relevant sections of this AEE Report chapter were it not for the fact that this information could endanger rare and legally protected species from wildlife crime, has been submitted to and assessed previously by the local planning authority, as part of the EIA process for SaxaVord Spaceport. For confidentiality reasons, this information is not included in the AEE submission.

Natural Capital

5.5.38 The most easterly headland on Lamba Ness, where the Proposed Project will be operated, is regularly used by local people and visitors for bird watching and whale watching.

5.6 Receptors Brought Forward for Assessment

5.6.1 Ornithological designated site interests on the Hermaness, Saxa Vord and Valla Field SPA (and overlapping Hermaness SSSI and Saxa Vord SSSI) and the following non-designated wider countryside ornithological receptors are taken forward for assessment: red-throated diver, merlin, black guillemot, common guillemot, puffin, razorbill, shag, kittiwake, fulmar, ringed plover, golden plover, whimbrel, curlew, dunlin, Arctic tern, Arctic skua and a confidential Schedule 1 species. The numbers of most gull species (with the exception of kittiwake) were considered small and trivial in relation to their overall regional population size and so have been scoped out of further consideration, as was gannet.

Potentially Important Ornithological Receptors

5.6.2 The conservation/legal importance of potentially important ornithological receptors was determined using criteria set out in Table 5.5. The importance of a species from a legal perspective in this listing does not equate to the importance of population at a site. The conservation importance of the birds using a site is evaluated by considering the number of individuals of species present in the context of geographical populations. A site can hold a protected species of importance, but the population present may not be regionally, nationally or internationally important. Thus, the occurrence of a legally protected species listed in Table 5.15 does not mean a site is necessarily important for that species.

Table 5.15 – Conservation Listing of Potentially Important Ornithological Receptors

Species	Conservation listing of target species
Red-throated diver	S1, A1
Gannet	Amber L
Black guillemot	Amber L
Common guillemot	Amber L

Species	Conservation listing of target species
Puffin	Red L
Razorbill	Amber L
Shag	Red L
Kittiwake	Red L
Fulmar	-
Merlin	A1, S1, Red L
Ringed plover	Red L
Golden plover	A1
Dunlin	A1 (*schinz*), Amber L
Whimbrel	S1, Red L
Curlew	Red L
Arctic tern	Amber L
Arctic skua	Red L
Great skua	Red L
Key: A1 = EC Birds Directive Annex I species, S1 = UK Wildlife and Countryside Act Schedule 1 species, Amber L = UK Birds of Conservation Concern Amber List Species, Red L = UK Birds of Conservation Concern Red List species.	

5.6.3 Geographical population estimates for potentially important bird species within the study area are provided in Table 5.16.

Table 5.16 – Geographical Population Estimates for Potentially Important Study Area Bird Species (breeding pairs unless stated)

Species	Shetland (Regional) population	Scotland population	UK National population	Europe population (International status)
Red-throated diver	407*	935-1,500	1,250	42,100-93,000 (Least Concern)
Gannet	42,183 AOS**	243,505 AOS**	295,000	683,000 (Least Concern)
Black guillemot	15,739 individuals***	18,750	19,500	304,000-742,000 individuals (Least Concern)

Species	Shetland (Regional) population	Scotland population	UK National population	Europe population (International status)
Common guillemot	172,681 individuals***	780,000	950,000	2,350,000-3,060,000 individuals (Least Concern)
Puffin	107,676 AOBs*	493,000	580,000	4,770,000-5,780,000 (Vulnerable)
Razorbill	9,492 individuals***	93,300	165,000	979,000-1,020,000 individuals (Near Threatened)
Shag	6,147 AON***	21,500-30,000	17,500	76,300-78,500 (Least Concern)
Kittiwake	16,732 AON***	282,200	205,000	1,730,000-2,200,000 (Vulnerable)
Fulmar	188,544 AOS***	486,000 AOS	350,000	3,380,000-3,500,000 (Least Concern)
Merlin	30*	800	1,150	32,000-51,600 (Least Concern)
Ringed plover	800-1,000*	4,900-6,700	5,300	140,000-213,000 (Least Concern)
Golden plover	5,665*	15,000	32,500-50,500	630,000-860,000 (Least Concern)
Dunlin	2,054*	8,000-10,000	8,600-10,500	426,000-562,000 (Least Concern)
Whimbrel	290*	400-500	310	343,000-402,000 (Least Concern)
Curlew	4,227*	58,800	58,500	212,000-292,000 (Near Threatened)

Species	Shetland (Regional) population	Scotland population	UK National population	Europe population (International status)
Arctic tern	24,716 AON***	47,300 AON	53,500	564,000-906,000 (Least Concern)
Arctic skua	516*	2,100	785	39,900-56,200 (Least Concern)
Great skua	6,846	9,650	9,650	16,300-17,200 (Least Concern)
Population estimate reference	*Wilson *et al.* 2015 **Murray *et al.* 2015 ***Mitchell *et al.* 2004	Wilson *et al.* 2015	Woodward *et al.* 2020	Birdlife International, 2015

AOB = Apparently Occupied Burrow, AOS = Apparently Occupied Site, AON = Apparently Occupied Nest. Quoting the most recent published estimate for geographical populations sometimes results anomalies, such as the apparently larger Scottish than UK population estimate for whimbrel. The UK population estimate of 310 pairs is more up to date than the older Scottish population estimate of 400-500 pairs. For whimbrel the 290 Shetland metric comes from work Dr Digger Jackson conducted in 2009 on the Viking Wind Farm and he reported that subsequent monitoring across west and central Shetland shows the population has not substantially changed since then. Furthermore, the 290 pairs metric originally quoted was based on a single survey visit and subsequent detailed whimbrel population monitoring work has shown that if two-three site visits are undertaken, then surveyors record ca. 10% more pairs. Consequently, the actual Shetland whimbrel population size is probably around ca. 320 pairs (D. Jackson, *pers com.*).

5.6.4 The behavioural sensitivity of the potentially important ornithological receptors is described using criteria set out in Table 5.17. When available, the assumed distance thresholds and hence sensitivity for disturbance in Table 5.17 was predominantly based on expert opinion examined by Ruddock and Whitfield (2007), Gilbert *et al.*, (1998), Scottish Government (2012) and field experience. The assessment of behavioural sensitivity is primarily based on disturbance to breeding birds at the nest, not general disturbance of birds undertaking other activities. However, note that the Scottish Government (2012) assessment of sensitivity was largely based around disturbance at sea foraging and not at the nest and each species was given a 'Disturbance Score' out of 5, where scoring categories were: 1 (hardly any escape behaviour and a very short flight distance when approached), to 5 (strong escape behaviour, at a large response distance).

5.6.5 A potentially useful and recognised method used to describe potential disturbance to birds involves two basic measures of receptor response (Ruddock and Whitfield, 2007):

- 'Alert Distance' (AD) – the distance between the disturbance source and the bird; at the point where the bird changes its behaviour in response to the approaching disturbance event.

➢ 'Flight Initiation Distance' (FID) – the point at which the bird flushes or flies away from the approaching disturbance event.

5.6.6 Where known, the difference between AD and FID in potentially important ornithological receptors is described based on published and unpublished research sources. However, few studies have looked in enough detail at AD and FID to differentiate these with any degree of rigour or confidence and often simply describe a 'flushed at' distance instead (equivalent to FID).

5.6.7 To understand potential impacts of short duration loud noise events, a background literature review of noise impacts on birds for the Proposed Project (Appendix 5.2) was undertaken. This literature review looked at how impulsive noise (from various sources including aircraft, fireworks, military ranges and rocket launches) impacts on both bird populations and individual behaviour and breeding success in order to help assess the potential noise impacts of the launches. To do this, the review focussed on identifying impulsive noise studies for the species of interest in Unst and specifically within the ornithological study area. A variety of freely available databases have been searched including ResearchGate and Google Scholar. References considered included both peer-reviewed published scientific papers and 'grey literature' reports. However, relevant literature was limited and so a wider literature search was conducted looking at other species including where possible analogous birds to those present in the ornithological study area.

5.6.8 Taking into account evidence from the literature review (Appendix 5.2), it is apparent that loud infrequent noise associated with Orbex PRIME Launch Vehicle launches could be expected to impact on birds in close proximity to operational launch pads. Less clear, are the ecological effects and consequences of the short duration loud disturbance impacts on these birds. Most studies consider potential impacts (e.g., startled response, increased vigilance etc.) and do not show or demonstrate long-term population level consequences or effects. Nevertheless, space centres can hold good breeding populations of birds, many of them declining species and conservation priorities. For example, the land immediately adjacent to the Kennedy Space Centre in Florida, USA, is home to large breeding populations of wading birds (Smith and Breininger, 1995), despite being exposed to irregular loud impulsive noise events.

Table 5.17 – Behavioural Sensitivity of Potentially Important Species

Species	Nature of sensitivity	Sensitivity level
Red-throated diver	Breeding birds are sensitive to human activity, visual disturbance and sudden noise events over large distances (up to 500 m). However, evidence from the Shetland Viking Wind Farm studies indicates that some individuals (perhaps habituated) appear to tolerate moderate levels of disturbance in some situations. The size of waterbodies also has an impact on FID; breeding birds are more easily disturbed and fly from small nesting lochans than large lochs, where they have the ability to swim away and/or dive without taking flight.	High at nest.

Species	Nature of sensitivity	Sensitivity level
Gannet	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity (1 = hardly any escape behaviour and a very short flight distance when approached, to 5 = strong escape behaviour, at a large response distance). Gannet scored 2. Gannets are highly traditional in where they breed (Mitchell *et al.,* 2004) and have increased at locations such as Sula Sgeir, where they are regularly disturbed and still exploited for food, with ca. 2,000 well-grown chicks harvested every year (Murray *et al.,* 2015).	Low at sea and nest.
Black guillemot	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Black guillemot scored 3, sometimes flying from approaching boats hundreds of metres away (FID). Elsewhere, e.g., Lerwick Harbour, the species nests in harbour wall holes in very close proximity to regular, but also unexpected human disturbance (both visual and noise) on water and land.	Moderate at sea. Low at nest.
Common guillemot	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Common guillemot scored 3, sometimes flying from approaching boats hundreds of metres away. Nest sensitivity considered to be moderate, with for example guillemots sometimes being flushed from ledges if boats get too close.	Moderate at sea and nest.
Puffin	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Puffin scored 2. Nest sensitivity considered low, with puffins able to tolerate large numbers of humans within a few metres of nesting burrows e.g., Sumburgh Head RSPB Reserve.	Low at sea and nest.
Razorbill	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Razorbill scored 3, sometimes flying from approaching boats hundreds of metres away. Nest sensitivity considered moderate.	Moderate at sea and nest.
Shag	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Shag scored 3. Nest sensitivity considered to be moderate, with for	Moderate at sea and nest.

Species	Nature of sensitivity	Sensitivity level
	example shag sometimes being flushed from ledges if boats get too close.	
Kittiwake	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Kittiwake scored 2. Nest sensitivity considered to be low.	Low at sea and nest.
Fulmar	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Fulmar scored 1. Nest sensitivity also considered to be low.	Low at sea and nest
Merlin	Breeding merlin are particularly sensitive to human activity, visual disturbance, and sudden noise events over large distances (up to 500 m). However, some individual merlins appear to tolerate moderate levels of disturbance in some situations. For example, some merlins appear to be able to nest relatively close to public roads, where regular disturbance occurs, including on Shetland.	High at nest
Ringed plover	Breeding ringed plovers have relatively small territories and regularly select to nest on man-made habitats in Shetland, such as road verges and quarries and so is not considered particularly susceptible or sensitive to human disturbance.	Low at nest
Golden plover	Breeding golden plovers have relatively small territories are sensitive to human activity, visual disturbance, and sudden noise events over moderate distances (~250 m).	Moderate at nest
Dunlin	Breeding dunlin have very small territories, are sensitive to human activity, visual disturbance and sudden noise events over moderate distances (~250 m).	Moderate at nest
Whimbrel	Breeding birds are usually considered sensitive to human activity, visual disturbance and sudden noise events. However, in Shetland whimbrel nest in short, grazed vegetation, periodically visited by crofters. Adult whimbrel on their breeding territories show disturbance responses to the presence of a moving or static person up to 250 m away (Massey *et al.,* 2016).	Moderate at nest
Curlew	Breeding birds are usually considered sensitive to human activity, visual disturbance and sudden noise events over moderate distances (~250 m). However, in Shetland curlews often nest and feed close to or on in-bye fields, which are regularly used by crofters, often on a daily basis.	Moderate at nest
Arctic tern	Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Arctic tern scored 2. Tern colonies are considered moderately	Low at sea, moderate at nest

Species	Nature of sensitivity	Sensitivity level
	sensitive; with total colony abandonment possible under some (poorly understood) circumstances.	
Arctic skua	Arctic skuas have relatively small nesting territories (sometimes within discrete colonies). Although birds aggressively defend territories, care needs to be taken around nests, especially not to flush young skuas which are vulnerable to predation by neighbouring adult Arctic and great skuas. Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Arctic skua scored 1.	Low at sea, low-moderate at nest
Great skua	Great skua colonies are relatively robust to human disturbance e.g., consider the 9,000 people who walk through the great skua colony at Hermaness annually[1]. Scottish Government advice (2012) on disturbance by wind farm structures, ship and helicopter traffic conducted a literature search focused on disturbance sensitivity of seabirds, and allocated scores by experts on sensitivity. Great skua scored 1.	Low at sea, low-at nest

5.6.9 The typical breeding calendar of the potentially important ornithological receptors within the study area is provided in Table 5.8. There is obviously overlap between the main egg laying/incubation period and the main period dependent young present. However, for simplicity, these main periods are separated out in Table 5.18.

Table 5.18 – Typical Breeding Calendar of Potentially Important Species

Species	April	May	June	July	Aug	Sept	Reference
Red-throated diver							Incubation 27 days; Fledging 43 days[1,2,3]
Gannet							Incubation 43 days; Fledging 90 days[1,2,3]
Black guillemot							Incubation 23-40 days; Fledging 40 days[1,2,3]
Common guillemot							Incubation 34 days; Fledging 20 days[1,2,3]
Puffin							Incubation 42 days; Fledging 50 days[1,2,3]

[1] Jonathan Swale (SNH) reported in the press that visitor numbers to Hermaness had gone up by 50% over the previous four years to 9,000 in 2019. https://www.shetnews.co.uk/2019/06/06/hermaness-path-to-be-upgraded-to-cope-with-rising-visitor-numbers/

Species	April	May	June	July	Aug	Sept	Reference
Razorbill							Incubation 34 days; Fledging 20 days[1,2,3]
Shag							Incubation 31 days; Fledging 53 days[1,2,3]
Kittiwake							Incubation 29 days; Fledging 43 days[1,2,3]
Fulmar							Incubation 51 days; Fledging 49 days[3]
Merlin							Incubation 30 days; Fledging 30 days[4]
Ringed plover							Incubation 24 days; Fledging 24 days[1,2,3]
Golden plover							Incubation 29 days; Fledging 30 days[1,2,3]
Dunlin							Incubation 22 days; Fledging 20 days[1,2,3]
Whimbrel							Incubation 28 days; Fledging 30 days[1,2,3]
Curlew							Incubation 28 days; Fledging 34 days[1,2,3]
Arctic tern							Incubation 22 days; Fledging 23 days[1,2,3]
Arctic skua							Incubation 27 days; Fledging 28 days[1,2,3]
Great skua							Incubation 29 days; Fledging 44 days[1,2,3]

Dark green = typical main egg laying/incubation period, light green = typical main period dependent young present. Note, table does not include relay or 2nd brood dates. 1 = Gilbert *et al.,* 1998 (reprinted 2011); 2 = Forrester and Andrews, 2007; 3 = Snow and Perrins, 1998; 4 = Hardey *et al.,* 2013.

5.6.10 A summary of the population size and percentage of geographical population estimates for potentially important bird species is provided in Table 5.19.

5.6.11 Whilst considering the potential consequences of loud impulsive noise events on important and sensitive bird species, consideration has also been given to SNH's ornithological comments and advice on the 2020 Sutherland Space Hub planning application. The Caithness and Sutherland Peatlands SPA and the Ben Hutig and A'Mhoine SSSI are 31 m away from the nearest access road and 109 m away from the launch pad of that Project. Thus, that Project is very close to the designated sites and their breeding birds, which include dunlin, greenshank, golden plover and red-throated diver; three of which breed within the study area.

5.6.12 In SNH's consultation response on the Sutherland Space Hub of 12/03/20 it stated that '*Disturbance through noise from launches has been evaluated in the EIAR and although the noise events are extremely loud, they will be very short-lived. From our own experience of blasting for construction and from military jets, it appears that sudden, loud noise events have short-term effects and do not appear to result in the permanent displacement of breeding birds. Therefore, our advice is that there is no basis for concluding adverse impact from the launches themselves*'.

Table 5.19 – Summary Population Size and Percentage of Geographical Population Estimates for Potentially Important Bird Species (breeding pairs unless stated). Species in bold match or exceed nominal 1% threshold of either the Regional or National population levels

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population	Population and % of Regional (and where relevant National) population within 4 km of launch pads (max est.)	Population and % of Regional population (and where relevant National) within 2 km of launch pads (max est.)	Population and % of Regional population within 1 km of launch pads (max est.)
Red-t diver	407	935-1,500	1,250	42,100-93,000	2 (0.5% of Regional pop)	0 (0%)	0 (0%)
Gannet	42,183 AOS	243,505 AOS	295,000	683,000	0 (0%)	0 (0%)	0 (0%)
Black guillemot	15,739 individuals	18,750	19,500	304,000-742,000 individuals	101 ind (0.64% of Regional pop)	50 ind (0.32% of Regional pop)	25 ind (0.16% of Regional pop)
Common guillemot	172,681 individuals	780,000	950,000	2,350,000-3,060,000 individuals	100 ind (0.06% of Regional pop)	27 ind (0.02% of Regional pop)	0 ind (0%)
Puffin	107,676 AOB	493,000	580,000	4,770,000-5,780,000	125 ind (0.06% of Regional pop*)	35 (0.02% of Regional pop*)	8 (0.004% of Regional pop*)
Razorbill	9,492 individuals	93,300	165,000	979,000-1,020,000 individuals	15 (0.16% of Regional pop)	0 (0%)	0 (0%)
Shag	**6,147 AON**	**21,500-30,000**	**17,500**	**76,300-78,500**	**81 (1.32% of Regional pop)**	**6 (0.1% of Regional pop)**	**1 (0.02% of Regional pop)**
Kittiwake	16,732 AON	282,200	205,000	1,730,000-2,200,000	55 (0.32% of Regional pop)	50 (0.3% of Regional pop)	0 (0%)

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population	Population and % of Regional (and where relevant National) population within 4 km of launch pads (max est.)	Population and % of Regional population (and where relevant National) within 2 km of launch pads (max est.)	Population and % of Regional population within 1 km of launch pads (max est.)
Fulmar	**188,544 AOS**	**486,000 AOS**	**350,000**	**3,380,000-3,500,000**	**6,987 (3.7% of Regional and 1.99% of National pop)**	**2,635 (1.4% of Regional pop)**	**1,170 (0.62%)**
Merlin	30	800	1,150	32,000-51,600 (Least Concern)	0 (0%), although one fledged brood recorded	0 (0%)	0 (0%)
Ringed plover	**800-1,000**	**4,900-6,700**	**5,300**	**140,000-213,000**	**10 (1.0-1.25% of Regional pop)**	**8 (0.8-1.0% of Regional pop)**	**3 (0.3-0.38% of Regional pop)**
Golden plover	5,665	15,000	32,500-50,500	630,000-860,000	13 (0.23% of Regional pop)	4 (0.07% of Regional pop)	1 (0.02% of Regional pop)
Dunlin	2,054	8,000-10,000	8,600-10,500	426,000-562,000	5 (0.24% of Regional pop)	3 (0.15% of Regional pop)	1 (0.05% of Regional pop)
Whimbrel	**[290] D. Jackson pop est. ca. 320**	**400-500**	**310**	**343,000-402,000**	**5 (1.7% of Regional and 1.6% of National pop). 1.6% of Regional pop using Jackson pop est**	**3 (1.04% of Regional pop). 0.9% of Regional pop using Jackson pop est**	**2 (0.69% of Regional pop). 0.63% of Regional pop using Jackson pop est**
Curlew	4,227	58,800	58,500	212,000-292,000	16 (0.4% of Regional pop)	3 (0.07% of Regional pop)	1 (0.02% of Regional pop)
Arctic tern	24,716 AON	47,300 AON	53,500	564,000-906,000	13(0.05% of Regional pop)	13 (0.05% of Regional pop)	0 (0%)

Species	Shetland (Regional) population	Scotland population	UK (National) population	Europe population	Population and % of Regional (and where relevant National) population within 4 km of launch pads (max est.)	Population and % of Regional population (and where relevant National) within 2 km of launch pads (max est.)	Population and % of Regional population within 1 km of launch pads (max est.)
Arctic skua	516	2,100	785	39,900-56,200	5 (0.97% of Regional pop)	3 (0.58% of Regional pop)	1 (0.19% of Regional pop)
Great skua*	6,846	9,650	9,650	16,300-17,200	Low tens (<1% of Regional pop)	0 (0%)	0 (0%)

AOB = Apparently Occupied Burrow, AOS = Apparently Occupied Site, AON = Apparently Occupied Nest. *metric assumes all individuals counted were breeding birds and AOB converted from number of individuals for comparative purposes. * For consistency with the original EIAR metrics, the same population references have been used. Birdflu had a severe impact on great skua populations nationally and so these population estimates do not reflect current population estimates, which are now much lower, resulting in the species being upgraded to the UK Red-list.

5.7 Standard Mitigation

5.7.1 Following CIEEM (2018, and subsequent amendments) guidance, the assessment process assumes the application of standard mitigation measures. A range of mitigation measures have already been in-built as part of the iterative design process for SaxaVord Spaceport, to avoid the higher value species and their habitats. As a Launch Operator working within the boundary of the SaxaVord Spaceport, the Applicant is committed to adhering to the following standard mitigation measures:

5.7.2 A detailed Breeding Birds Protection Plan, required as a planning condition for SaxaVord Spaceport, has been produced and will be updated regularly through targeted breeding bird surveys. The Applicant will adhere to any recommendations set out in this document.

5.7.3 Following the NatureScot consultation response dated 11 March 2021, SaxaVord Spaceport has made a commitment to a 'no-launch window' whereby no launches will be carried out between mid-May and the end of June (subject to ongoing monitoring and appraisal). The Applicant is aware of this operational constraint and will not schedule launches within the defined mid-May to end of June window.

5.7.4 As applicable, the Applicant will comply with the SaxaVord Spaceport Habitat Management Plan, required as a planning condition for SaxaVord Spaceport (Appendix 5.3).

5.8 Potential Effects

Designated Sites

5.8.1 Internationally important populations of birds are present within the Hermaness, Saxa Vord and Valla Field SPA, including red-throated diver (3% of British population), gannet (8% of British and 6% of world population), great skua (9% of British and 6% of world population) and puffin (6% of British population). The SPA also regularly supports over 150,000 breeding seabirds which include 4% of the British fulmar population, 1% of the British shag population, 2% of the British common guillemot population and 2% of the British kittiwake population (https://sitelink.nature.scot/site/8512).

5.8.2 SNH provided Alba Ecology with the designated sites' breeding bird data on 02/06/20 (Table 5.20).

Table 5.210 – Behavioural Sensitivity of Potentially Important Species

Species	Saxa Vord SSSI	Hermaness SSSI/NNR	Valla Field
Red-throated diver		5 pairs (2015-2016), 6 pairs (2018-2019)	12 pairs (2012-2013), average 18 pairs in past
Common guillemot	1,948 ind. (2017)	5,808 ind. (2016)	

Species	Saxa Vord SSSI	Hermaness SSSI/NNR	Valla Field
Puffin	217 ind. (2017)	11,455 AOB (2017)*	82 ind. (2016)
Razorbill	42 ind. (2017)	139 ind. (2016)	
Shag	32 AON (2017)		
Kittiwake	95 AON (2017)	171 AON (2016)	
Fulmar	8,057 AOS (2016)	11,786 AOS (2016)	1,146 AOS (2016)
Gannet		25,580 AON (2014)*	
Merlin		1 pair (2018)	
Arctic skua		2 AON (2016, 2018, 2019), 1 AON (2017)	
Great skua		955 AON (2018)	198 AOT (2013)

*Puffin estimate calculated from counts of loafing birds and so has a wide margin of error (Jonathan Swale, *pers comm.*). **Following the 2022 birdflu (H5N1) outbreak, the virus has killed tens of thousands of seabirds, including many in key Shetland colonies of gannets and great skuas. Consequently, published population estimates (which are based on pre birdflu estimates) are unlikely to reflect actual numbers, which may be substantially lower than these quoted metrics.

5.8.3 The distance between the nearest land part of the Hermaness, Saxa Vord and Valla Field SPA (at the Noup) and Launch Pad 3 is 4.5 km.

5.8.4 Based on the Applicant's maximum monthly launch program, up to six launches could in theory take place annually between April and June, the main incubation period for the SPA birds. However, it should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.5 In the context of the Sutherland Space Hub, the launch pad of which was 109 m from the nearest part of the Caithness and Sutherland Peatlands SPA, SNH considered that '*loud noise events have short-term effects and do not appear to result in the permanent displacement of breeding birds. Therefore, our advice is that there is no basis for concluding adverse impact from the launches themselves*' and therefore it seems unlikely that Hermaness, Saxa Vord and Valla Field SPA birds, the nearest of which are approximately 4.5 km away from Launch Pad 3, would be adversely affected by the predicted maximum noise levels at launch.

5.8.6 Under this scenario, the potential magnitude of adverse impacts of operational (noise) disturbance on designated site bird species would likely be negligible, with no likely significant effects predicted.

Ornithological Receptors

Red-throated Diver

5.8.7 Red-throated diver is an Annex 1 and Schedule 1 species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be high (Table 5.17). The regional, national and international population estimates of this species are known (Table 5.16). The Shetland NHZ red-throated diver population estimate was 407 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.8 The species nests on the edge of freshwater lochs and lochans, often within blanket bog/peatland. The adults usually forage away from the breeding lochs, feeding in the sea, or occasionally large freshwater lochs and carry fish back to the chicks (Forrester and Andrews, 2007). Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they always nest within 1 m of a loch/lochan shore, can only use certain types of waterbody (whose characteristics are well known) and regularly use the same lochs and lochans over time.

5.8.9 Details of potential operational impacts on red-throated diver have been provided in a confidential appendix previously to the local planning authority in accordance with SNH (2016) guidance.

5.8.10 The potential magnitude of adverse impacts of operational disturbance combined on red-throated diver would likely be negligible, with no likely significant effects predicted. Although red-throated diver is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates, that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Red-throated diver is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of red-throated diver in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the red-throated diver population on a long-term basis should the Proposed Project operate.

Black Guillemot

5.8.11 Black guillemot is an Amber listed species and therefore of moderate conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be low at the nest (Table 5.17). The regional, national and international population estimates of this species are known (Table 5.16). The Shetland NHZ black guillemot population estimate is 15,739 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.12 The species typically nests on predator-free islands with suitable boulder beaches in loose colonies, or at lower densities on cliffs inaccessible to mammalian predators (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable ‘fixed constraint’ insofar as they nest within the same boulder beach and cliff habitats over time.

5.8.13 With a maximum of 101 black guillemots breeding within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project. Noise modelling of the SaxaVord Spaceport representative launch vehicle (RepLV), which has significantly more sea level thrust and is therefore considered to be significantly louder than the Orbex PRIME Launch Vehicle, has been completed by BRRC and is described in detail in Chapter 8. Data relevant to ecology has been summarised and assessed below.

5.8.14 Table 5.2 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting black guillemot. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.21 – Maximum Predicted Decibel Levels at Black Guillemot Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
13-14 ind, 0-0.5 km	120-130dB	110-130dB
8-12 ind, 0.5-1 km	100-110dB	100-110dB
25-27 ind, 1-2 km	90-110dB	90-110dB
25-26 ind, 2-3 km	90-100dB	80-100dB
10-25 ind, 3-4 km	90-100dB	80-90dB

5.8.15 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding black guillemot within the study area and there is also no threshold noise metric against which to compare potential effects on black guillemot. However, pigeon guillemot (Cepphus columba), a similar analogous Pacific species has shown adverse responses to fireworks near nesting sites in California (Appendix 5.2).

5.8.16 Breeding black guillemot are not considered particularly sensitive to human activity, visual disturbance and sudden noise events at the nest, as evidenced by the range of nesting sites provided by Forrester and Andrews (2007). Nevertheless, whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds (in the underground nest) to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 23-40 day incubation period for black guillemot (Table 5.18). It should be noted that following the NatureScot consultation response to the

Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.17 If a worst-case (not likely) scenario is assumed (a failure for all breeding black guillemot directly related to a launch) then this would constitute an adverse impact on 101 individuals out of Shetland's 15,739 individual black guillemots, i.e., 0.64% of the regional population (Table 5.19). If no such adverse response took place, then 0% of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional black guillemot population in Shetland is considered unlikely.

5.8.18 Under either of these scenarios, the potential magnitude of adverse impacts of operational disturbance on black guillemot would likely be negligible, with no likely significant effects predicted. Although black guillemot is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operated, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Black guillemot is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of black guillemot in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the black guillemot population on a long-term basis should the Proposed Project be operated.

Common Guillemot

5.8.19 Common guillemot is an abundant Amber listed species and therefore of moderate conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be moderate at the nest (Table 5.17). The regional, national and international population estimates of this species are known (Table 5.16). The Shetland NHZ common guillemot population estimate is 172,681 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.20 The species typically nests in colonies, often containing many thousands of pairs, in locations inaccessible to mammalian predators e.g., ledges on sheer cliffs, tops of stacks and among boulders and flat ground on offshore islands (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same sheer cliff habitats over time.

5.8.21 With a maximum of 100 common guillemots breeding within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.22 Table 5.2 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting common guillemot. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.22 – Maximum Predicted Decibel Levels at Common Guillemot Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
27 ind, 1-2 km	90-110dB	90-110dB
20 ind, 2-3 km	90-100dB	80-100dB
53 ind, 3-4 km	90-100dB	80-90dB

5.8.23 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding common guillemot within the study area and there is also no threshold noise metric against which compare potential effects on common guillemot.

5.8.24 A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting on breeding seabirds recorded the reactions of a mixed seabird colony, including common guillemots, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.25 Breeding common guillemots are considered moderately sensitive to human activity, visual disturbance, and sudden noise events at the nest. Based on the literature available (Appendix 5.2) on common guillemot (called common murre in the USA publications) on disturbance from planes/helicopters suggests that this species is most sensitive to flushing in the pre-egg laying/early egg laying period. Flushing in this species occasionally causes eggs/chicks to be dislodged. However, it is not known if such dislodging of eggs/chicks is additive in terms of overall mortality, as sub-optimal nest locations regularly lose eggs/chicks naturally in the breeding season regardless. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Such activity would likely to be most severe during pre-egg laying and early incubation period. Based on the likely launch schedule, launches could take place during the typical 34-day incubation period for common guillemot (Table 5.18). It should be noted that following the NatureScot consultation response to the

Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.26 If a worst-case (not likely) scenario is assumed (a failure for all breeding common guillemots directly related to a launch) then this would constitute an adverse impact on 100 individuals out of Shetland's 172,681 individual common guillemots, i.e., 0.06% of the regional population (Table 5.19). If no such adverse response took place, then 0% of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional common guillemot population in Shetland is considered unlikely.

5.8.27 Under either of these scenarios, the potential magnitude of adverse impacts of operational disturbance on common guillemot would likely be negligible, with no likely significant effects predicted. Although common guillemot is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Common guillemot is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of common guillemot in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the common guillemot population on a long-term basis should the Proposed Project be operated.

Puffin

5.8.28 Puffin is a common Red listed species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be low at the nest (Table 5.17). The regional, national and international population estimates of this species are known (Table 5.16). The Shetland NHZ puffin population estimate is 107,676 AOB and with recent evidence of an apparent decline the species in Shetland (e.g., Owen *et al*., 2018), puffin is not likely to be in FCS within Shetland.

5.8.29 The species typically nests within burrows (dug in soil and less commonly among boulders) in colonies, in locations inaccessible to mammalian predators (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same burrow habitats over time.

5.8.30 With a maximum of 125 individuals breeding within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.31 Table 5.23 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting puffin. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.23 – Maximum Predicted Decibel Levels at Puffin Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
2 ind, 0-0.5 km	120-130dB	110-130dB
6 ind, 0.5-1 km	100-110dB	100-110dB
27 ind, 1-2 km	90-110dB	90-110dB
23 ind, 2-3 km	90-100dB	80-100dB
67 ind, 3-4 km	90-100dB	80-90dB

5.8.32 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding puffin within the study area and there is also no threshold noise metric against which compare potential effects on puffin.

5.8.33 A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including puffins, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.34 Breeding puffins are considered tolerant of human activity, visual disturbance, and sudden noise events at the nest. Based on the literature available, puffins hearing range is between 500h hz to 6,000 hz (Appendix 5.2) so they would certainly hear the noise at launch. The presence of puffin nests in underground burrows will substantially reduce the potential noise at nests. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Such activity would probably be most severe during pre-egg laying and the incubation period (early April to the end of May). Based on the likely launch schedule, launches could take place during the typical 42-day incubation period for puffin (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.35 If a worst-case (not likely) scenario is assumed (a failure for all breeding puffins directly related to a launch) then this would constitute an adverse impact on 125 individuals (assuming they were all breeders, which is unlikely) out of Shetland's 107,676 AOB (215,352 individuals), i.e., 0.06% of the regional population (Table 5.19). If no such adverse response took place, then 0% of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional puffin population in Shetland is considered unlikely.

5.8.36 Under either of these scenarios, the potential magnitude of adverse impacts of operational disturbance on puffin would likely be negligible, with no likely significant effects predicted. Although puffin is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Puffin is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of puffin in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.

5.8.37 There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the puffin population on a long-term basis should the Proposed Project be operated.

Razorbill

5.8.38 Razorbill is an Amber listed species and therefore of moderate conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be moderate at the nest (Table 5.17). The regional, national and international population estimates of this species are known (Table 5.16). The Shetland NHZ razorbill population estimate is 9,492 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.39 The species typically nests on open rocky coastlines, low cliffs and boulder scree slopes, particularly on offshore islands to high precipitous cliffs. Razorbills can nest individually or within loose groups (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same cliff habitats over time.

5.8.40 With a maximum of 15 razorbills breeding within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.41 Table 5.11 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting razorbill. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.11 – Maximum Predicted Decibel Levels at Razorbill Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
2 ind, 2-3 km	90-100dB	80-100dB
13 ind, 3-4 km	90-100dB	80-90dB

5.8.42 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding razorbill within the study area and there is also no threshold noise metric against which compare potential effects on razorbill.

5.8.43 A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including razorbills, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.44 Breeding razorbills are considered low-moderately sensitive to human activity, visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Such activity would probably be most severe during pre-egg laying and early incubation period (early April to the end of May). Based on the likely launch schedule, launches could take place during the typical 34-day incubation period for razorbill (Table 5.8). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.45 If a worst-case (not likely) scenario is assumed (a failure for all breeding razorbill directly related to a launch) then this would constitute an adverse impact on 15 individuals out of Shetland's 9,492 individual razorbills, i.e., 0.16% of the regional population (Table 5.19). If no such adverse response took place, then 0% of the regional population would be adversely affected. Under both of these scenarios, a significant operational impact on the regional razorbill population in Shetland is considered unlikely.

5.8.46 Under both of these scenarios, the potential magnitude of adverse impacts of operational disturbance on razorbill would likely be negligible, with no likely significant effects predicted. Although razorbill is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Razorbill is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of razorbill in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the razorbill population on a long-term basis should the Proposed Project be operational.

Shag

5.8.47 Despite being a common and widespread resident breeding species throughout Scotland (Forrester and Andrews, 2007), shag is a Red listed species and therefore of high conservation importance (Table 5.15). Relatively recent surveys of shags have revealed mixed fortunes across colonies from severe decline e.g., Foula (Heubeck *et al.,* 2014), relatively stable populations in the Outer Hebrides (Taylor *et al.,* 2018) to increases elsewhere such as Argyll and north-east Scotland (Forrester and Andrews, 2007). Nevertheless, whilst still numerous, when assessed in 1998-2002, the Britain and Ireland shag population revealed a widespread decline since the mid-1980s, for poorly understood reasons (Mitchell *et al.,* 2004).

5.8.48 The behavioural sensitivity of the species is considered to be low at the nest (Table 5.17). A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including shags, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.49 The regional, national and international population estimates of this species are known (Table 5.16). The Shetland NHZ shag population estimate is 6,147 individuals and without evidence to the contrary the species is likely to be in FCS within Shetland, Foula notwithstanding.

5.8.50 The species typically nests among boulders on small islands and at the bases of cliffs, in caves, crevices and less commonly on flat open ledges and high sea cliffs (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same boulder and cliff habitats over time.

5.8.51 With a maximum of 81 shag AON within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.52 Table 5.2 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting shag. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.25 – Maximum Predicted Decibel Levels at Shag Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
1 AON, 0-0.5 km	120-130dB	110-130dB
5 AON, 1-2 km	90-110dB	90-110dB
24 AON, 2-3 km	90-100dB	80-100dB
51 AON, 3-4 km	90-100dB	80-90dB

5.8.53 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding shag within the study area and there is also no threshold noise metric against which compare potential effects on shag. Dunnet's (1977) research suggests that shag may have a tolerance for unexpected loud noises. However, the volume of a launch will exceed that of an aircraft flying within 100 m of nesting shags.

5.8.54 Breeding shags are considered to have low sensitive to human activity, visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 31 day incubation period for shag (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.55 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding shag directly related to a launch) then this would constitute an adverse impact on 81 AON out of Shetland's 6,147 AON, i.e., 1.32% of the regional shag population (Table 5.19). If no such adverse response took place, then 0% of the regional population would be adversely affected. The former worst-case scenario would constitute a minor impact on the regional shag population in Shetland. The question therefore follows, how likely is this worst-case complete breeding failure to occur? Based on Dunnet's (1977) work, it is apparent that shags can tolerate unexpected loud noises and with the vast majority of shag AON in the study area (75 out of the 81) greater than two kilometres away from launch sites, it seems highly unlikely that such a worst-case scenario would occur. Therefore, were any adverse effect to occur (and there is no direct evidence that it would) it would most likely occur on the six AON within two kilometres of the launch pad site (ca. 0.1% of the regional population).

5.8.56 Consequently, the potential magnitude of adverse impacts of operational disturbance on shag would likely be negligible, with no likely significant effects predicted. Although shag is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Shag is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of shag in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the shag population on a long-term basis should the Proposed Project be operated.

Kittiwake

5.8.57 Despite being a common and widespread breeding species throughout coastal Scotland (Forrester and Andrews, 2007) and the most numerous gull species in the world (Mitchell *et al.,* 2004), kittiwake is a Red listed species in the UK and therefore of high conservation importance (Table 5.15). The national censuses suggested that the Scottish population increased by 4% between 1969-70 and 1985-88, but then declined by 21% by 1998-2002, with the greatest declines in Shetland (Mitchell *et al.,* 2004; Forrester and Andrews, 2007). Although this decline occurred throughout most of the British Isles, there was substantial regional variation in trends. Oceanographic changes (resulting in reduction of their food) and predation of kittiwakes by an expanding great skua population in Shetland are believed to have contributed significantly to the overall decline in kittiwakes in Shetland (Mitchell *et al.,* 2004).

5.8.58 The behavioural sensitivity of the species is considered to be low at the nest (Table 5.17). A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including kittiwakes, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.59 The regional, national, and international population estimates of this species are known (Table 5.16). The Shetland NHZ kittiwake population estimate is 16,732 AON and based on successive seabird surveys the species is unlikely to be in FCS within Shetland.

5.8.60 The species typically nests colonially on vertical rock cliffs, offshore stacks and, occasionally, on man-made structures (Forrester and Andrews, 2007). The adults feed at sea and carry fish back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same cliff habitats over time.

5.8.61 With a maximum of 55 kittiwake AON within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.62 Table 5.2 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting kittiwake. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.26 – Maximum Predicted Decibel Levels at Kittiwake Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
50 AON 1-2 km	90-110dB	90-110dB
5 AON 3-4 km	90-100dB	80-90dB

5.8.63 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding kittiwake within the and there is also no threshold noise metric against which compare potential effects on kittiwake. Dunnet's (1977) research suggests that kittiwake may have a tolerance for unexpected loud noises. However, the volume of a launch will exceed that of an aircraft flying within 100 m of nesting kittiwake.

5.8.64 Breeding kittiwakes are considered to have low sensitive to human activity (for example, they have bred on buildings and structures along the quayside at the busy Newcastle-Gateshead Quayside on the River Tyne in north-east England since the 1960s), visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 29-day incubation period for kittiwake (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.65 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding kittiwake directly related to a launch) then this would constitute an adverse impact on 55 AON out of Shetland's 16,732 AON, i.e., 0.32% of the regional kittiwake population (Table 5.19). If no such adverse response took place, then 0% of the regional kittiwake population would be adversely affected. How likely is this worst-case complete breeding failure to occur? Based on Dunnet's (1977) work, it is apparent that kittiwakes can tolerate unexpected loud noises and with none within one kilometre of the launch site and 50 AON within two kilometres, it seems unlikely that such a worst-case scenario would occur. Therefore, were any adverse effect to occur (and there is no direct evidence that it would) it would most likely occur on the 50 AON within two kilometres of the launch sites (ca. 0.3% of the regional population).

5.8.66 Consequently, the potential magnitude of adverse impacts of operational disturbance on kittiwake would likely be negligible, with no likely significant effects predicted. Although kittiwake a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected.

5.8.67 Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Kittiwake is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of kittiwake in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the kittiwake population on a long-term basis should the Proposed Project be operated.

Fulmar

5.8.68 Fulmar is one of the commonest seabirds around Britain (Mitchell *et al.,* 2004) particularly in the Northern Isles and Outer Hebrides, but also breeding in coastal areas throughout Scotland (Forrester and Andrews, 2007). The spectacular growth in fulmar numbers across Britain in the 20th Century is one of the best documented for any bird species (Mitchell *et al.,* 2004). It is the only bird species taken forward for assessment within this EIA Report chapter that is not conservation listed or specially protected, i.e., it is not Amber or Red listed and does not appear on Schedule 1 of the 1981 Wildlife and Countryside Act or Annex 1 of the Birds Directive (Table 5.15) and is therefore of low conservation importance. Nevertheless, it was taken forward in this assessment based on the relatively large number of AOS recorded within the study area and because SNH specifically mentioned the species during EIA Scoping (Table 5.1).

5.8.69 The behavioural sensitivity of the species is considered to be low at the nest (Table 5.17). A study (Dunnet, 1977) to explore the possibility that an increase in air traffic associated with oilfields off the north-east of Scotland was impacting breeding seabirds recorded the reactions of a mixed seabird colony, including fulmars, on the Buchan cliffs in relation to aircraft flying within 100 m. Virtually no behavioural reaction was reported as a result of the flyovers to within 100 m of the colony which was conducted during early egg laying and early nestling periods (Appendix 5.2).

5.8.70 The regional, national and international population estimates of this species are known (Table 5.16). The Shetland NHZ fulmar population estimate is 188,544 AOS and the species is likely to be in FCS within Shetland. The species typically nests on cliffs on islands and open coasts, both on vegetated and bare ledges. It can also nest in dunes and on shorelines on low, mammalian predator free, islands. Occasionally it nests on man-made structures such as bridges and quarries (Forrester and Andrews, 2007). The adults feed at sea and bring food back to the chicks. Consequently, the breeding sites are a relatively predictable 'fixed constraint' insofar as they nest within the same cliff and open coast habitats over time.

5.8.71 With a maximum of 6,987 fulmar AOS within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.72 Table 5.12 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting fulmar. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.12 – Maximum Predicted Decibel Levels at Fulmar Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
430 AON 0-0.5 km	120-130dB	110-130dB
740 AON 0.5-1 km	100-110dB	100-110dB
1,465 AON 1-2 km	90-110dB	90-110dB
2,645 AON 2-3 km	90-100dB	80-100dB
1,707 AON 3-4 km	90-100dB	80-90dB

5.8.73 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, breeding fulmar within the study area and there is also no threshold noise metric against which compare potential effects on fulmar. Dunnet's (1977) research suggests that fulmar may have a tolerance for unexpected loud noises. However, the volume of a launch will exceed that of an aircraft flying within 100 m of nesting fulmar.

5.8.74 Breeding fulmars are considered to have low sensitivity (high tolerance) to human activity, visual disturbance and sudden noise events at the nest. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 51-day incubation period for fulmar (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.75 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding fulmar directly related to a launch) then this would constitute an adverse impact on 6,987 AOS out of Shetland's 188,544 AOS, i.e., 3.7% of the regional fulmar population (Table 5.19). Based on Dunnet's (1977) work, it is apparent that fulmars can tolerate unexpected loud noises and so it seems highly unlikely that such a worst-case scenario would occur. If no such adverse response took place, then 0% of the regional fulmar population would be adversely affected. However, this is also considered unlikely given the large number of AOS widely spread throughout the study area, and with 1,170 AOS within one kilometre of launch facilities (ca. 0.6% of regional population), it is considered likely that some of these fulmars will be adverse affected and some breeding attempts may fail, but it is not known how many, but possibly some of the 430 AON within 0.5 km of the launch pads.

5.8.76 Consequently, the potential magnitude of adverse impacts of operational disturbance on fulmar would likely be negligible on the regional population, with no likely significant effects predicted. Fulmar is not a species of conservation importance, and the likely effects are judged to be not significant, i.e., there would be little/no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Fulmar is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of fulmar in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the fulmar population on a long-term basis should the Proposed Project be operated.

Merlin

5.8.77 Merlin is scarce upland breeding raptor that predominantly nests in heather moorland, usually on sloping ground on hillsides (Forrester and Andrews, 2007). Merlin is an Annex 1, Schedule 1 and Red listed species and therefore is considered to be of High conservation importance (Table 5.15). The behavioural sensitivity of the species is considered High (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The Shetland NHZ merlin population estimate is ca. 30 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.78 The favoured merlin breeding territories tend to be used year after year. Consequently, the breeding sites are relatively predictable, but new sites can and are used in different years. Nesting sites are relatively difficult to find and consequently the species is somewhat under-recorded.

5.8.79 As there is no evidence that merlins nest within the study area, the species is unlikely to be susceptible to disturbance from operation of the Proposed Project and no likely significant effects are predicted.

5.8.80 Consequently, the potential magnitude of adverse impacts of operational disturbance on merlin would equate to no effect on the regional population, with no likely significant effects predicted. Although merlin is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Merlin is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of merlin in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the merlin population on a long-term basis should the Proposed Project be operated.

Ringed Plover

5.8.81 Ringed plover is a largely coastal wader species, nesting on or above the strandline on open sand and shingle beaches, but can also use sand dunes, grass hinterlands, rocky headlands, maritime heath, small storm beaches and artificial habitats (Forrester and Andrews, 2007). Ringed plover is a Red listed species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered low (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The Shetland NHZ ringed plover population estimate is 800-1,000 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.82 The favoured breeding sites tend to be used year after year and evidence from 2018 and 2019 surveys shows a high degree of overlap in terms of ringed plover territories. Consequently, the breeding sites are a relatively predictable ‘fixed constraint’, but new sites can and are used in different years.

5.8.83 With a maximum of 10 pairs of ringed plover within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.84 Table 5.13 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting ringed plover. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.13 – Maximum Predicted Decibel Levels at Ringed Plover Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
3 pairs, 0-0.5 km	120-130dB	110-130dB
4-5 pairs, 1-2 km	90-110dB	90-110dB
1-2 pairs, 2-3 km	90-100dB	80-100dB
0-1 pair, 3-4 km	90-100dB	80-90dB

5.8.85 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding ringed plover within the study area and there is also no threshold noise metric against which compare potential effects on ringed plover. The literature review (Appendix 5.3) identified studies on two potentially analogous coastal wader species: Wilson’s plover (*Charadrius wilsonia*) and snowy plover (*Charadrius nivosus*). The Wilson’s plover study reported military flights increased bird’s alertness and scanning behaviour, but with no evidence of effect on heart rate or incubation, or direct evidence of this behavioural response reducing reproductive success. The snowy plover study was focused on Titan IV rocket launches (130 dBA) and the birds did not exhibit any adverse reactions to a launch, and monitoring during the breeding season recorded no injury or mortality to adults, young, or eggs following smaller launches and concluded behaviour was not adversely affected by launch noise.

5.8.86 The lack of an adverse response of the analogous snowy plover to rocket launches up to 130 dBA suggests that *Charadrius* plovers maybe relatively robust/tolerant of sudden, very loud noise events and so worst-case scenarios (where all 10 breeding pairs fail) within the study area are considered unlikely to occur. Nevertheless, one-two pairs are particularly close (<250 m) to the launch pads and so are potentially most likely to be adversely affected by operational disturbance. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 24-day incubation period for ringed plover (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.87 If a worst-case (*not likely*) scenario is assumed (a failure for all breeding ringed plover directly related to a launch) then this would constitute an adverse impact on 10 pairs out of Shetland's 800-1,000 pairs, i.e., approximately 1% of the regional ringed plover population (Table 5.19). However, based on the responses of analogous *Charadrius* plovers to rocket launches in the USA, this seems an unlikely scenario. If no such adverse response took place, then 0% of the regional ringed plover population would be adversely affected. However, this is also considered unlikely given that the territories of one-two pairs in 2018-2019 were located close enough to launch pads (<250 m) to assume that they would likely be adversely affected and possibly fail.

5.8.88 Consequently, the potential magnitude of adverse impacts from operational disturbance on ringed plover would likely be negligible on the regional population, with no likely significant effects predicted. Although ringed plover is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Ringed plover is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of ringed plover in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the ringed plover population on a long-term basis should the Proposed Project be operated.

Golden Plover

5.8.89 Golden plover breeds in semi-natural moorland, dwarf shrub, peatland and arctic alpine heath (Forrester and Andrews, 2007). Golden plover is an Annex 1 wader species and therefore of high conservation importance (Table 5.15), although it is still a quarry species that can legally be shot in season in the UK. The behavioural sensitivity of the species is considered moderate (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The

Shetland NHZ golden plover population estimate is 5,665 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.90 There is high annual variation in terms of site occupancy (e.g., with seven breeding pairs recorded in the study area in 2018 and 13 pairs in 2019) and is a feature of many upland golden plover populations Alba Ecology has worked on. Consequently, the breeding sites are considered relatively unpredictable in terms of annual occupancy, although some favoured territories appear to be regularly used.

5.8.91 With a maximum of 13 pairs of golden plover within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.92 Table 5. outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicleon nesting ringed plover. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.29 – Maximum Predicted Decibel Levels at Golden Plover Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
0-1 pair, 0-0.5 km	120-130dB	110-130dB
2-3 pairs, 1-2 km	90-110dB	90-110dB
1-5 pairs, 2-3 km	90-100dB	80-100dB
4 pairs, 3-4 km	90-100dB	80-90dB

5.8.93 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding golden plover within the study area and there is also no threshold noise metric against which compare potential effects on golden plover. The literature review (Appendix 5.2) identified studies on two potentially analogous *Charadrius* species: Wilson’s plover and snowy plover. The Wilson’s plover study reported military flights increased birds’ alertness and scanning behaviour, but with no evidence of effect on heart rate or incubation, or direct evidence of this behavioural response reducing reproductive success. The snowy plover study was focused on Titan IV rocket launches (130 dBA) and the birds did not exhibit any adverse reactions to a launch, and monitoring during the breeding season recorded no injury or mortality to adults, young, or eggs following smaller launches and concluded behaviour was not adversely affected by launch noise or vibrations. Furthermore, studies of golden plover breeding on the Otterburn firing range in northern England showed an apparent population increase from 25 pairs in 1994 to 34 pairs in 1998 despite regular loud noise disturbance from live firing and explosions (Appendix 5.2).

5.8.94 The lack of an adverse response of the analogous snowy plover to rocket launches up to 130 dBA and population increases of golden plover in an English live fire range despite explosive noise disturbance suggests that *Charadrius* plovers are relatively robust/tolerant of sudden, very loud noise events and so worst-case scenarios (where all 13 breeding pairs fail) within the study area are considered unlikely to occur. Nevertheless, one pair in 2019 was particularly close <250 m) to the launch pads and so would potentially be most likely to be adversely affected by operational disturbance. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 29-day incubation period for golden plover (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.95 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding golden plover directly related to a launch) then this would constitute an adverse impact on a maximum of 13 pairs out of Shetland's 5,665 pairs, i.e., 0.23% of the regional golden plover population (Table 5.19). However, based on the responses of analogous *Charadrius* plovers to rocket launches in the USA and golden plover breeding success at an English live firing range, this seems an unlikely scenario. If no such adverse response took place, then 0% of the regional golden plover population would be adversely affected. However, this is also considered unlikely given that one territory (if subsequently used) is located close enough to launch pads to assume that they would likely be adversely affected and possibly fail.

5.8.96 Consequently, the potential magnitude of adverse impacts of operational disturbance on golden plover would likely be negligible on the regional population, with no likely significant effects predicted. Although golden plover is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH use to consider FCS):

- Golden plover is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of golden plover in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.

- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the golden plover population on a long-term basis should the Proposed Project be operated.

Dunlin

5.8.97 Dunlin breeds on wet upland and montane heath, especially where bog pool systems occur, but also on machair and rarely on salt marsh (Forrester and Andrews, 2007). Dunlin (sub-species *schinzii*, which breeds in Shetland) is an Annex 1 wader species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered moderate (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The Shetland NHZ dunlin population estimate is 2,054 pairs and without evidence to the contrary the species is likely to be in FCS within Shetland.

5.8.98 There is high annual variation in terms of site occupancy (e.g., with five breeding pairs recorded in the study area in 2018 and four pairs in 2019, mostly in different locations). Consequently, the breeding sites are considered relatively unpredictable in terms of annual occupancy, although some favoured territories appear to be regularly used.

5.8.99 With a maximum of five pairs of dunlin within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.100 Table 5.3 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting dunlin. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.30 – Maximum Predicted Decibel Levels at Dunlin Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
0-1 pair, 0-0.5 km	120-130dB	110-130dB
2 pairs, 1-2 km	90-110dB	90-110dB
0-1 pair, 2-3 km	90-100dB	80-100dB
1-2 pairs, 3-4 km	90-100dB	80-90dB
0-1 pair, 0-0.5 km	120-130dB	110-130dB

5.8.101 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding dunlin within the study area and there is also no threshold noise metric against which compare potential effects on dunlin. The literature review (Appendix 5.2) did not identify any directly relevant studies on dunlin or potentially analogous wader species. Based on current information it is not possible to predict likely responses of all breeding dunlin to the noise caused by the launches, but it is considered that one territory occupied in 2019 would likely be adversely affected (were it to be subsequently occupied) by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 22-day incubation period for dunlin (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.102 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding dunlin directly related to a launch) then this would constitute an adverse impact on a maximum of five pairs out of Shetland's 2,054 pairs, i.e., 0.24% of the regional dunlin population (Table 5.19). However, based on the predicted responses of other waders, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0% of the regional dunlin population would be adversely affected. However, this is also considered unlikely given that one territory (in 2019) was located close enough to launch pads to assume that they would likely be adversely affected were it to be subsequently occupied.

5.8.103 Consequently, the potential magnitude of adverse impacts of operational disturbance combined on dunlin would likely be negligible on the regional population, with no likely significant effects predicted. Although dunlin is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Dunlin is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of dunlin in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the dunlin population on a long-term basis should the Proposed Project be operated.

Whimbrel

5.8.104 Within Shetland, whimbrel breed in short vegetation on wet heath, blanket bog and serpentine heath (Grant 1991; Massey *et al.,* 2016). Whimbrel is a Schedule 1 and Red listed wader species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be moderate (Table 5.17). The national and international population estimates of this species are known (Table

5.16). The published Shetland NHZ whimbrel population estimate is 290 pairs, but should be increased by 10% (Digger Jackson, *pers comm.*) to ca. 320 pairs. The current status of the Shetland population is unknown, but detailed monitoring across west and central Shetland suggests it has not substantially changed over the last decade and consequently the species is probably in FCS within Shetland, especially with great skua, believed to be the main culprit in the species' decline (at least in the Northern Isles), now apparently in decline itself. It should be noted that the RSPB quote that the Shetland and Orkney breeding population has been slowly increasing and the UK population estimate to be 400-500 pairs (https://www.rspb.org.uk/birds-and-wildlife/wildlife-guides/bird-a-z/whimbrel/). It is not clear on what the much higher RSPB population data is based, but it is considered potentially misleading and so has not been used within this assessment.

5.8.105 There is a relatively low variation in terms of site occupancy (with five breeding pairs recorded in the study area in 2018 and four pairs in 2019, mostly in similar locations). Consequently, the breeding sites are considered relatively predictable in terms of annual occupancy.

5.8.106 Details of potential impacts on whimbrel have been provided previously in a confidential appendix to the local planning authority in accordance with SNH (2016) guidance.

5.8.107 The potential magnitude of adverse impacts of operational disturbance on whimbrel would likely be negligible on the regional (which also is almost all the national) population, with no likely significant effects predicted, as discussed below. Although whimbrel is a species of high conservation importance and probably in FCS, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Whimbrel is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of whimbrel in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the whimbrel population on a long-term basis should the Proposed Project operate.

Curlew

5.8.108 Curlew is a widespread but declining Scottish breeding bird on farmland and uplands (Forrester and Andrews, 2007). Curlew is a Red listed wader species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be moderate (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The Shetland NHZ curlew population estimate is 4,227 pairs and without evidence to the contrary, the species is likely to be in FCS within Shetland.

5.8.109 There is relatively low variation in terms of site occupancy, with many territories occupied in both years of survey (e.g., there were ca. 16 breeding territories in 2018 and ca. 13 in 2019). Consequently, the breeding sites are considered relatively predictable in terms of annual occupancy.

5.8.110 With a maximum of 16 pairs of curlew within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.111 Table 5. outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting curlew. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.31 – Maximum Predicted Decibel Levels at Curlew Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
0-1 pair, 0-0.5 km	120-130dB	110-130dB
2-3 pairs, 1-2 km	90-110dB	90-110dB
5 pairs, 2-3 km	90-100dB	80-100dB
5-8 pairs, 3-4 km	90-100dB	80-90dB

5.8.112 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding curlew within the study area and there is also no threshold noise metric against which compare potential effects on curlew. The literature review (Appendix 5.2) did not identify any directly relevant noise studies on breeding curlew or potentially analogous wader species (although it did note some evidence of noise disturbance impacts on wintering curlew). Based on current information it is not possible to predict likely responses of all breeding curlew to the noise caused by the launches, but it is considered that one-two regularly occupied territories would likely be adversely affected by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 28-day incubation period for curlew (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.113 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding curlew directly related to a launch) then this would constitute an adverse impact on a maximum of 16 pairs out of Shetland's 4,227 pairs, i.e., 0.4% of the regional curlew population (Table 5.19). However, based on the distribution of curlew territories and predicted responses of other waders, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0% of the regional curlew population would be adversely affected. However, this is also considered unlikely given that one-two territories are located close enough to launch pads to assume that they would likely be adversely affected. Were that scenario to take place, this would constitute an adverse effect (loss) of 0.02-0.05% of the regional curlew population.

5.8.114 Consequently, the potential magnitude of adverse impacts of operational disturbance on curlew would likely be negligible on the regional population, with no likely significant effects predicted. Although curlew is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Curlew is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of curlew in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the curlew population on a long-term basis should the Proposed Project be operated.

Arctic Tern

5.8.115 Arctic tern is a widespread coastal breeding summer visitor, with strongholds in Orkney and Shetland (Forrester and Andrews, 2007). Arctic tern is an Amber listed species and therefore of moderate conservation importance (Table 5.15). The behavioural sensitivity of the species at the nest is considered to be moderate (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The Shetland NHZ population estimate is 24,716 AON and without evidence to the contrary, the species is likely to be in FCS within Shetland.

5.8.116 There is some variation in terms of site occupancy, with a few small breeding colonies present within the study area, which fluctuate annually in terms of occupancy.

5.8.117 With a maximum of 13 Arctic tern AON within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.118 Table 5.14 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting arctic tern. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.14 – Maximum Predicted Decibel Levels at Arctic Tern Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
8-13 pairs, 1-2 km	90-110dB	90-110dB
0-1 pair, 2-3 km	90-100dB	80-100dB

5.8.119 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding Arctic tern within the study area and there is also no threshold noise metric against which compare potential adverse effects on Arctic tern. The literature review (Appendix 5.2) found that Arctic tern incubating behaviour is impacted by both fixed-wing aircraft and helicopters, with helicopters causing more disturbance to birds than fixed-wing aircraft, however human presence had a larger effect than aircraft disturbance. Based on current information it is not possible to predict likely responses of all breeding Arctic tern to the noise caused by the launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 22-day incubation period for Arctic tern (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.120 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding Arctic tern directly related to a launch) then this would constitute an adverse impact on a maximum of 13 AON out of Shetland's 24,716 AON, i.e., 0.05% of the regional Arctic tern population (Table 5.19). However, given the distance between the small Arctic tern colonies and the launch sites, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0% of the regional Arctic tern population would be adversely affected and this seems most likely.

5.8.121 Consequently, the potential magnitude of adverse impacts of operational disturbance on Arctic tern would likely be negligible on the regional populations, with no likely significant effects predicted. Although Arctic tern is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Arctic tern is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of Arctic tern in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the Arctic tern population on a long-term basis should the Proposed Project be operated.

Arctic Skua

5.8.122 Arctic skua is a localised and apparently declining breeding species in Scotland (Forrester and Andrews, 2007). Arctic skua is a Red listed species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be moderate at the nest (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The Shetland NHZ population estimate is 516 pairs and without evidence to the contrary, the species is unlikely to be in FCS within Shetland.

5.8.123 There is annual variation in terms of site occupancy, but some territories were occupied in both years of survey (there were five breeding territories in 2018 and 2019). Consequently, some of the breeding sites are relatively predictable in terms of annual occupancy.

5.8.124 With a maximum of five pairs of Arctic skua within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.125 Table 5.15 outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting arctic skua. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.15 – Maximum Predicted Decibel Levels at Arctic Skua Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
1 pair, 0.5-1 km	100-110dB	100-110dB
1-2 pairs, 1-2 km	90-110dB	90-110dB
2-3 pairs, 2-3 km	90-100dB	80-100dB

5.8.126 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding Arctic skua within the study area and there is also no threshold noise metric against which compare potential effects on

Arctic skua. The literature review (Appendix 5.2) did not identify any directly relevant noise studies on breeding Arctic skua or potentially analogous species. Based on current information it is not possible to predict likely responses of all breeding Arctic skua to the noise caused by the launches, but it is considered that one regularly occupied territory (approximately 600 m away from Launch Pad 3) would likely be adversely affected by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 27-day incubation period for Arctic skua (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.127 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding Arctic skua directly related to a launch) then this would constitute an adverse impact on a maximum of five pairs out of Shetland's 516 pairs, i.e., 0.97% of the regional Arctic skua population (Table 5.19). However, given the distance away of some territories, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0% of the regional Arctic skua population would be adversely affected. However, this is also considered unlikely given that one territory is located close enough to launch pads to assume that they would likely be adversely affected. Were that scenario to take place, this one pair would constitute an adverse effect (loss) on 0.19% of the regional Arctic skua population.

5.8.128 Consequently, the potential magnitude of adverse impacts of operational disturbance on Arctic skua would likely be negligible on the regional population, with no likely significant effects predicted. Although Arctic skua is a species of high conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates, that the conservation status would not likely be affected because (as articulated using three tests SNH (2006) use to consider FCS):

- Arctic skua is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of Arctic skua in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the Arctic skua population on a long-term basis should the Proposed Project be operated.

Great Skua

5.8.129 Great skua is a localised breeding species in Scotland (Forrester and Andrews, 2007). Great skua is now a Red listed species and therefore of high conservation importance (Table 5.15). The behavioural sensitivity of the species is considered to be low at the nest (Table 5.17). The national and international population estimates of this species are known (Table 5.16). The Shetland NHZ population estimate is 6,846 pairs (this data is from prior to the H5N1 outbreak and population is now much lower) and without evidence to the contrary, the species is unlikely (in the long-term) to be in FCS within Shetland[2]. A study of abundance data in Scotland from 1992 to 2015 indicated that great skuas increased at most sites, with some very large increases at smaller colonies. However, declines at the two largest colonies (Foula and Hoy) resulted in little overall change in AOTs across all colonies combined (https://jncc.gov.uk/our-work/great-skua-stercorarius-skua/#conservation-status).

5.8.130 The difficulties in distinguishing between non-breeding and breeding pairs holding territory, makes estimates of annual site occupancy challenging (unless undertaken as part of detailed single species monitoring). Consequently, the surveys do not provide sufficient information to comment on annual site occupancy in any detail. At best, the surveys provide evidence of breeding pairs in the low tens, with breeding mainly concentrated over three kilometres away from the Proposed Project around Saxa Vord hill.

5.8.131 With tens of pairs of great skua within the study area, all will be within the range of elevated noise levels predicted for operation of the Proposed Project.

5.8.132 Table 5.3outlines the modelled maximum predicted dB levels from launch of Orbex PRIME Launch Vehicle on nesting great skua. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 5.34 – Maximum Predicted Decibel Levels at Great Skua Nesting Locations around Launch Pad 3

Individuals	Launch LAmax	Static LAmax
Low tens of pairs, 3-4 km	90-100dB	80-90dB

5.8.133 There is no direct evidence to suggest that the noise at launch would impact on, and adversely affect the success of, all the breeding great skua within the study area and there is also no threshold noise metric against which compare potential effects on great skua. The literature review (Appendix 5.2) did not identify any directly relevant

[2] In common with many parts of Shetland, Unst breeding bird surveys in 2022 recorded several dead species which were presumed to have died from birdflu (H5N1 is the strain of avian flu in Scotland). According to the RSPB, the virus has killed tens of thousands of seabirds, including many in key Shetland colonies of gannets and great skuas in 2022 (How together we can protect wild birds from Avian Flu | The RSPB). The conservation status of great skua (and other affected birds such as gannet) was re-evaluated and recently upgraded from the UK Amber to Red list.

noise studies on great skua or potentially analogous species. Based on current information it is not possible to predict likely responses of all breeding great skua to the noise caused by the launches. Nevertheless, with most of the tens of pairs 3-4 km away from the launch site, few if any breeding pairs would likely be adversely affected by operational noise during launches. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle, building to a maximum, followed by a rapid decrease back to baseline will be sufficient to allow the birds to cope with the noise is currently speculative. Based on the likely launch schedule, launches could take place during the typical 29-day incubation period for great skua (Table 5.18). It should be noted that following the NatureScot consultation response to the SaxaVord Spaceport planning application (11 March 2021), commitment to a no-launch window, whereby no launches will be carried out between mid-May and the end of June, has subsequently been made by SaxaVord Spaceport and will be adhered to by the Applicant.

5.8.134 If a worst-case scenario (*not likely*) is assumed (a failure for all breeding great skua directly related to a launch) then this would constitute an adverse impact on a maximum of low tens of pairs out of Shetland's 6,846 pairs, (Table 5.19). However, given the large distance away of most breeding territories (which anyway have disappeared since the H5N1 outbreak), this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0% of the regional great skua population would be adversely affected and this seems most likely.

5.8.135 Consequently, the potential magnitude of adverse impacts of operational disturbance on great skua would likely be negligible on the regional population, with no likely significant effects predicted. Although great skua is a species of moderate conservation importance, the likely effects are judged to be not significant, i.e., there would be no detectable regional population level impacts and so the Shetland NHZ would not be adversely affected. Therefore, if the Proposed Project was operational, the available information indicates that conservation status would not likely be affected because (as articulated using three tests SNH use to consider FCS):

- Great skua is likely to maintain itself on a long-term basis as a viable component of its habitat in the Shetland NHZ.
- The natural range of great skua in the Shetland NHZ would not be reduced by the Proposed Project, nor would it become likely to be reduced in the foreseeable future.
- There would be (and would continue to be) a sufficiently large habitat area in the Shetland NHZ to maintain the great skua population on a long-term basis should the Proposed Project be operated.

Collision Risk during Orbex PRIME launches

5.8.136 The collision risk of a bird with an Orbex PRIME Launch Vehicle is considered to be unlikely and consequently no likely significant effects on any important ornithological receptor are predicted. The tiny vertical airspace in which an Orbex PRIME Launch

Vehicle will use will only be occupied for a few seconds during each launch. Each launch will be preceded by the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle. It is anticipated that this will scare birds away from the immediate vicinity of the launch pad prior to the launch.

5.8.137 The ornithological study area extends to 4 km from the Launch site. At 4 km ground track along the Orbex PRIME Launch Vehicle sub-orbital and orbital trajectories respectively, the Orbex PRIME Launch Vehicle altitude will be approximately 31,100 m (31.1 km) and 7,720 m (7.72 km); significantly above the area in which birds fly in both cases. As such the collision risk to birds in the EZI but outwith the ornithological study area is considered to be negligible.

5.8.138 As part of previous AEEs undertaken for SaxaVord Spaceport, the CAA has requested specific information on the altitude of launch vehicles at 1.5 km, 3 km, 4 km, 5 km and 10 km from the launch location, relating to the Hermaness, Saxa Vord and Valla Field Special Protection Area (SPA). For Orbex PRIME Launch Vehicle sub-orbital (1b) and orbital (SSO) launches the respective altitudes at these distances are provided below:

- At 1.5 km groundtrack – 1b: 31.1 km altitude / SSO: 7.72 km altitude
- At 3 km ground track – 1b: 49 km altitude / SSO: 10.9 km altitude
- At 4 km groundtrack – 1b: 59.3 km altitude / SSO: 12.6 km altitude
- At 5 km groundtrack - 1b: 69.8 km altitude / SSO: 14.1 km altitude
- At 10 km groundtrack - 1b: 115.4 km altitude / SSO: 20.4 km altitude

5.9 Additional Mitigation

5.9.1 The Habitat Management Plan for SaxaVord Spaceport identifies seven objectives, three of which are focussed on breeding Schedule 1 bird species and therefore relevant to this chapter.

5.9.2 Two of the objectives, creation of breeding pools and protection/restoration of existing pools, target mitigation for species likely to be adversely affected by the Spaceport and hence the Proposed Project. The third objective, habitat creation, is better described as enhancement as the objective is for a receptor where no adverse or likely significant effects are predicted. All objectives are the responsibility of SaxaVord Spaceport but will be adhered to by the Applicant as applicable.

5.9.3 After mitigation, no significant residual effects are predicted.

5.10 Residual Effects

5.10.1 No likely significant residual effects are predicted.

5.11 Cumulative Assessment

5.11.1 Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location (CIEEM, 2018). This guidance goes on to say that '*developments to be included in the cumulative impact assessment should be in accordance with national guidance'*.

5.11.2 NatureScot provides no advice or guidance in relation to the cumulative impacts of a spaceport. CIEEM (2018) state in relation to cumulative assessment that '*Information about developments within the zone(s) of influence may be available in other EcIAs, Local Plan documents, Marine Spatial Plans, Strategic Environmental Assessments (SEAs), Sustainability Appraisals (SAs), Water Framework Directive Assessments (WFDAs), and Habitats Regulations Assessments/Appraisals (HRAs), including "Natura Impact Statements" (NISs) / "Natura Impact Reports" (NIRs), "Information / Reports to Inform an Appropriate Assessment", "Shadow Habitats Regulations Assessments" and, for Nationally Significant Infrastructure Projects, "Reports on the Implications for European Sites" (RIES)'*.

5.11.3 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent. As such, as far as the Applicant is aware, there are no like for like or similar projects within the ornithological study area or wider EZI and therefore, no significant issues are likely to arise from developments other than SaxaVord Spaceport.

5.11.4 SaxaVord Spaceport has a proposed capacity for 30 launches per annum. The Proposed Project will account for 10 of those launches.

5.11.5 A comparison of the Orbex PRIME Launch Vehicle against the RepLV used as the basis of assessment in the SaxaVord Spaceport AEE has been undertaken; the composition and fuelling specifics of the two launch vehicles has been assessed and a review of environmental effect significance from the two vehicles carried out. It has been confirmed that for ornithological effects, the Orbex PRIME Launch Vehicle is within the limiting case assessed for SaxaVord Spaceport - sub-orbital and orbital launches of small satellites into either polar or sun-synchronous, low-earth orbits. As such the assessment of cumulative ornithological effects completed for the SaxaVord Spaceport AEE is considered appropriate to this AEE.

5.11.6 Therefore, assuming operators are identified for the remaining capacity, the cumulative ornithological effects of all 30 launches would be expected to be as documented in the SaxaVord Spaceport AEE:

'The ornithological study area (out to four kilometres from the Proposed Project) is an equivalent to the potential 'zone of influence' and as there are no existing or proposed developments within that area, no significant issues are considered likely to arise from inter-project additive or cumulative effects.

Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. The interactions between noise and ornithology have been identified and assessed within this chapter, and no other environmental topic are considered likely to give rise to potential intra-project cumulative effects.'

5.12 Summary

5.12.1 Targeted and licensed breeding bird surveys were undertaken following agreed standardised survey methods between 2018 and 2020 (and subsequently for seabirds) within the ornithological study area. A total of 135 bird species were recorded during breeding bird surveys. There was direct evidence of potentially sensitive and specially protected bird species breeding within, and adjacent to, the Proposed Project boundary.

5.12.2 Ornithological designated site interests on the Hermaness, Saxa Vord and Valla Field SPA (and overlapping Hermaness SSSI and Saxa Vord SSSI) and the following non-designated wider countryside ornithological birds are taken forward for assessment: red-throated diver, merlin, black guillemot, common guillemot, puffin, razorbill, shag, kittiwake, fulmar, ringed plover, golden plover, whimbrel, curlew, dunlin, Arctic tern, Arctic skua, great skua and a confidential Schedule 1 species.

5.12.3 To understand potential impacts of loud, short duration noise events, a background literature review of noise impacts on relevant bird species was undertaken. This literature review looked at how impulsive noise (from various sources including aircraft, fireworks, military ranges and rocket launches) impacted on birds in order to help assess the potential noise impacts of the launches.

5.12.4 Potential impacts from the Proposed Project (preparation and launch of the Orbex PRIME Launch Vehicle) have been assessed. The magnitude of predicted operational effects is either 'no effect' or 'negligible' for all bird species considered except one. Minor operational impacts are predicted for a confidential Schedule 1 breeding species (although there was no evidence of this species recorded during breeding bird surveys in 2022 and subsequently).

5.12.5 Confidential bird species information has been submitted to and assessed previously by the local planning authority, as part of the planning process for the Proposed Project.

5.12.6 All likely effects are assessed as non-significant, apart from a confidential Schedule 1 species, where minor magnitude operational effects are considered likely to be significant in the absence of mitigation.

5.12.7 Confidential bird species information has been submitted to and assessed previously by the local planning authority, as part of the planning process for the Proposed Project.

5.12.8 Mitigation measures inherent to operation of the Proposed Project, as confirmed and implemented through planning conditions for SaxaVord Spaceport, are outlined in Appendix 5.3: Habitat Management Plan and comprise of the following elements that will benefit ornithological receptors: large-scale peatland restoration, creation of native broadleaved riparian woodland, coastal grassland management, off-site red-throated diver lochan habitat restoration/protection, habitat creation for a Schedule 1 breeding bird and whimbrel chick habitat creation.

5.12.9 A summary of the magnitude of predicted residual effects on target bird species is provided in Table 5..

Table 5.35 – Magnitude of Predicted effects on target Species

Species	Magnitude of predicted effects
Red-throated diver	No likely significant effect
Black guillemot	No likely significant effect
Common guillemot	No likely significant effect
Puffin	No likely significant effect
Razorbill	No likely significant effect
Shag	No likely significant effect
Kittiwake	No likely significant effect
Fulmar	No likely significant effect
Merlin	No likely significant effect
Ringed plover	No likely significant effect
Golden plover	No likely significant effect
Dunlin	No likely significant effect
Whimbrel	No likely significant effect
Curlew	No likely significant effect
Schedule 1 species*	No likely significant effect
Arctic tern	No likely significant effect
Arctic skua	No likely significant effect
Great skua	No likely significant effect

*minor magnitude operational effects were considered likely to be significant before mitigation. After mitigation applied, effects are predicted likely to be not significant.

5.12.10After mitigation, all residual effects are predicted likely to be not significant.

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Chapter 6 Ecology and Biodiversity

6. Ecology and Biodiversity

6. Ecology and Biodiversity

6.1 Introduction

6.1.1 This chapter considers the likely effects of the Proposed Project on ecological receptors on-site, in the surrounding ecological study area and within the environmental zone of influence (EZI) This assessment is based upon comprehensive baseline data, comprising specifically targeted ecological surveys of potentially important and legally protected ecological receptors identified during the desk study and consultation feedback. It draws on pre-existing information, where appropriate, survey data and Chartered Institute for Ecology and Environmental Management (CIEEM) best practice guidance. The scope of the ecological assessment excludes potential impacts on birds, which are considered separately in Chapter 5: Ornithology.

6.1.2 Alba Ecology Limited led on all aspects of the ecological fieldwork and assessment of the Proposed Project. Alba Ecology is a Scottish-based multi-disciplinary ecological consultancy that has worked in the north of Scotland, and Shetland specifically, for many years. Alba Ecology's staff have led on and contributed to all aspects of Ecological Impact Assessment (EcIA) on many large-scale development projects, including the management of Ecological Clerks of Work teams, principal ornithological/ecological surveyors and advisors on planning applications, expert witness advice at Public Local Inquiry and production of EcIA Reports, Habitat Regulations Assessments and Habitat Management Plans.

6.1.3 The ecological surveyors used between 2018 and 2024 were Dr Peter Cosgrove, Brydon Thomason, Donald Shields, Dr Fergus Massey and Dr Kate Massey. The ecological surveyors have extensive ecological field experience of Shetland, and Unst specifically, and have attended regular training events led by experts, covering areas such as species identification, recording data concisely and accurately, navigation techniques and health and safety. The surveyors were trained to carry out surveying and mapping work in a systematic manner, following recognised standardised survey methods. When ecological surveys required working near birds listed in Schedule 1 of the Wildlife and Countryside Act 1981 (and as amended) in the breeding season they were covered by relevant Scottish Natural Heritage (now NatureScot) Schedule 1 Bird Licences.

6.1.4 This chapter is supported by the following documents:

- Appendix 5.3: SaxaVord Spaceport Habitat Management Plan.
- Appendix 6.1: Natural Heritage Desk Study.
- Appendix 6.2: Phase 1 Habitat, National Vegetation Classification (NVC) and Potential Groundwater dependent Terrestrial Ecosystem (GWDTE) Survey Report.
- Appendix 6.3a: Otter Survey Report and Species Protection Plan, 2022.
- Appendix 6.3b: SaxaVord Spaceport Pre-construction Otter Survey Report, 2022.
- Appendix 6.3c: SaxaVord Spaceport Otter Survey Report and Species Protection Plan, 2024.

- Appendix 6.4: Freshwater Pearl Mussel Survey Report.
- Appendix 6.5: SaxaVord Spaceport AEE Chapter 9: Water.

6.1.5 This chapter should be read alongside other chapters within the AEE Report, in particular Chapters 2, 3, 4, 5, and 10.

6.1.6 The assessment involved the following key phases:

- Reference to relevant legislation, policy and guidance.
- Identification of study area and wider EZI of the Proposed Project.
- Identification of potentially important ecological receptors likely to be affected (baseline conditions) by the Proposed Project.
- Evaluation of important ecological receptors and features likely to be affected by the Proposed Project.
- Identification of likely impacts and magnitude of the Proposed Project works on important ecological receptors.
- Assessment of the likely significant effects of the Proposed Project, including any mitigation and enhancement measures and definition of any residual significant effects.

6.1.7 The term '*receptor*' is used throughout this AEE and is defined as the element in the environment affected by a Project (e.g., a species or habitat in the case of ecology). The term '*impact*' is also used commonly throughout the AEE and is defined as a change experienced by a receptor (this can be beneficial, neutral or adverse). The term '*effect*' is defined as the consequences for the receptor of an impact.

6.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

6.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

6.2.2 As the Applicant wishes to become a spaceflight operator and launch Orbex PRIME Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the proposed project.

Space Industry Regulations 2021

6.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Policy Context

6.2.4 Further relevant legislation and best practice guidance documents have been reviewed and taken into account as part of this ecological assessment. The approach used to assess the significance of likely effects of the Proposed Project upon ecological receptors is set in the context of:

- The Wildlife and Countryside Act 1981 (as amended);
- European Commission (EC) (2011) European Biodiversity Strategy;
- European Commission (EC) (2020). European Biodiversity Strategy;
- EC Directive 1992/43/EEC on the conservation of natural habitats and of wild fauna and flora. The so-called 'Habitats Directive';
- The Conservation (Natural Habitats) Regulations 1994. The so-called Habitats Regulations;
- The Conservation of Habitats and Species Regulations 2010;
- The Nature Conservation (Scotland) Act 2004 (as amended);
- Scottish Government PAN 1/2013;
- Guidelines for Ecological Impact Assessment in the UK and Ireland (CIEEM, 2018, v 1.3 (2024));
- Scottish Government. The Scottish Biodiversity List (SBL);
- Scottish Government 2020. The Environment Strategy for Scotland: vision and outcomes;
- Biodiversity Net Gain: Good practice principles for development: A practical guide. (CIRIA, CIEEM and IEMA 2019);
- Biodiversity New Gain in Scotland, CIEEM Scotland Policy Group, 2019;
- Strategic Plan for Biodiversity 2011-2020. Convention on Biological Diversity;
- Land-use planning system Scottish Environment Protection Agency (SEPA) Guidance Note 31: Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems. LUPG-GU31 Version 3 (SEPA, 2017);
- The Fourth National Planning Framework (NPF4) (2023); and
- Living Shetland Local Biodiversity Action Plan (LBAP) documents.
- The Shetland Local Development Plan (2014); and
- The Shetland Local Development Plan – Natural Heritage Supplementary Guidance (2012).

- Scottish Biodiversity Strategy (SBS) to 2045: Tackling the Nature Emergency (2023).
- Scottish Government Draft Planning Guidance: Biodiversity (2023).

6.2.5 There is no Scottish or UK specific ecological guidance on satellite launch operations.

6.2.6 The recently published Scottish Government's Planning Guidance: Biodiversity sets out expectations for implementing and delivering National Planning Framework (NPF) 4 policies which support the outcome 'improving biodiversity. NPF4 (2023) is designed to support Scotland's commitment of reaching net zero emissions and thereby tackling the climate change emergency.

6.2.7 The UK Biodiversity Action Plan (BAP) was the UK Government's 2004 response to the Convention on Biological Diversity, to which the UK was a signatory. Action plans for the most threatened species and habitats (called 'UK BAP species and habitats') were set out to aid recovery. Following the publication of the Convention on Biological Diversity's 'Strategic Plan for Biodiversity 2011–2020' (Convention on Biological Diversity, 2010), its commitment to 20 'Aichi targets', agreed at Nagoya Japan in October 2010, and the launch of the European Biodiversity Strategy in May 2011 the UK Government has changed its strategic thinking.

6.2.8 The Scottish Biodiversity List (SBL) is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland, under the Nature Conservation (Scotland) Act 2004. The SBL therefore supersedes the UK BAP list of species and habitats (CIEEM, 2017). Nevertheless, since most current planning policy and SNH guidance requires consideration of, and makes explicit reference to, UK BAP species and habitats and the definitions of SBL habitats are largely based on UK BAP definitions, these are still referred to where necessary.

6.2.9 The Shetland Local Development Plan (2014) contains policies and objectives to conserve and enhance the habitats and species that contribute to the unique character and heritage of Shetland. It has links to Supplementary Guidance on Local Nature Conservation Sites in Shetland and Supplementary Guidance on Natural Heritage. This guidance is provided to aid planning applicants and their agents when considering development in relation to their biodiversity responsibilities.

6.2.10 Whilst considering a range of potential outcomes that could arise from the Proposed Project, the assessment reports the effects that are considered likely to be significant on the basis of evidence, standard guidance and professional judgement. It is these likely significant effects that the Applicant is obliged to report, and that the decision maker is obliged to consider.

Relevant Guidance

Guidance for the Assessment of Environmental Effects

6.2.11 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note 'CAP2215 Guidance for the Assessment of Environmental Effects' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

6.2.12 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including ecology and biodiversity.

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

6.2.13 The Department for Transport issued its document 'Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objective for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*
- *Protect people and wildlife from the impacts of noise from spaceflight activities; and*
- *Protect the marine environment from the impact of spaceflight activities.*

6.2.14 The objectives presented in the guidance are noted to be consistent with the environmental topics that must be addressed in an AEE.

6.3 Consultation and Required Surveys

6.3.1 Extensive statutory consultation on ecological matters was carried out during preparation and determination of the planning application for SaxaVord Spaceport, from where the Proposed Project will operate. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application phase have been summarised in Table 6.1. In addition, notes on relevant planning conditions received from Shetland Islands Council are also included for information.

Table 6.1 – Record of Consultation and relevant Planning Conditions

Consultee	Summary Ecological Response	Where and How Addressed
Scottish Natural Heritage (SNH; now NatureScot) 16/02/18	*Otters* *"Otters are protected by law, making it an offence to disturb one in a holt or whilst it is caring for its young, or to destroy, damage or obstruct access to a holt"* *SNH provided a link to SNH's standing advice on otters (in May 2020 this was superseded by NatureScot standing advice on otters, which is essentially the same as the previous SNH standing advice).* *SNH provided standing advice for planning consultation with regard to otter. It states that "this is standing advice to help planning applicants seeking permission for development that could affect otters, and to assist planning officers and other regulators in their assessment of these applications. It avoids the need for us to advise on individual planning consultations in relation to otters. We will only provide further advice in exceptional circumstances that are not covered by this standing advice".* *SNH went on to say that "in Shetland, otters are predominantly coastal animals, however natal holts (places of shelter where cubs are born and reared) are usually hidden inland and away from watercourses…If a holt is found it may be necessary to submit a species protection plan with your planning application and consider whether a licence might be required for the development".*	Otter surveys are reported in Appendix 6.3 and are considered throughout this chapter. An otter licence has been granted from NatureScot (2025-2029, License No. 280355).
SNH (NatureScot) 16/02/18	*Plants* *"The key plant species, referred to in the Alba Ecology report, are the Shetland endemic Edmondston's chickweed (Cerastium nigrescens) and serpentine dandelion (Taraxacum serpenticola), nationally rare Norwegian sandwort (Arenaria norvegica) and nationally scarce northern rock-cress (Arabis petraea), all of which have very limited distributions in areas with ultrabasic "serpentine" bedrock with natural or semi-natural vegetation. Only the former RAF camp and Baltasound airport are in serpentine areas, and on the first of these the vegetation has been highly modified so none of these species is likely to be present. Consequently, the proposed rare plant survey can be restricted to the airport".*	Baltasound airport, though associated with SaxaVord Spaceport, does not form part of the Proposed Project Boundary and therefore no rare plant surveys are required for this AEE. A detailed Phase 1 Habitat and NVC survey of the Proposed Project site was conducted during the standard field season. Plant species records

Consultee	Summary Ecological Response	Where and How Addressed
		are listed in Appendix 6.2 and are considered in Sections 6.4 and 6.5. Habitats and, associated plant species are reported in Appendix 6.2 and considered in Sections 6.4, 6.5, 6.6 and 6.8. Following survey updates undertaken in 2022, the baseline surveys are considered robust.
SNH (NatureScot) 16/02/18	Marine mammals *"Noise and vibration from onshore activity close to the coast, such as drilling and blasting (and potentially rocket launching) can affect cetaceans so should not be scoped out at this stage, however there is no need for a survey of marine mammals as the assessment of potential impacts and any necessary mitigation can be generic in nature."*	Marine mammals are considered in Chapter 10.
Shetland Islands Council, SaxaVord Spaceport Planning Conditions document (1/4/2022).	NatureScot: *Scottish Natural Heritage (SNH) – SNH are content that the* [SaxaVord Spaceport] *can be progressed with appropriate mitigation... They also identified that mitigation measures identified in the* [SaxaVord Spaceport] *EIAR will reduce to some extent the impact on otters, a European Protected Species, and any licence required from them would be granted.*	Otter surveys undertaken by SaxaVord Spaceport are reported in Appendix 6.3 and are considered throughout this chapter. An otter licence has been granted from NatureScot (2025-2029, License No. 280355).
Shetland Islands Council, SaxaVord Spaceport Planning	Condition 17 Otter Protection Plan *No development* [of SaxaVord Spaceport] *shall commence unless and until:* *(a) i) a pre-construction otter survey is conducted and a report produced;*	Otter surveys, including the SaxaVord Spaceport pre-construction otter survey are

Consultee	Summary Ecological Response	Where and How Addressed
Conditions document (1/4/2022).	*ii) based on the results from the pre-construction otter survey apply for an otter licence, if necessary, from NatureScot; and* *iii) until such otter licence (if necessary) is issued, not carry out any works on any otter holts.; and* *(b) an Otter Protection Plan (OPP) has been submitted to and approved in writing by the Planning Authority following consultation with NatureScot, which shall provide for a programme of future monitoring for otters on the site to allow the adaptation of management under the approved OPP as may be agreed to in writing by the Planning Authority.*	reported in Appendix 6.3. The current SaxaVord Spaceport Otter Protection Plan is also provided as Appendix 6.3c (note that this is a 'live document' and so regularly updated). Otters are considered throughout this chapter. An otter licence has been granted from NatureScot (2025-2029, License No. 280355).

6.3.2 Given the geographical location and habitats present, and in consultation with SNH (now NatureScot), the protected mammal survey focussed on determining the potential presence of otter (*Lutra lutra*). All terrestrial mammal species in Shetland are non-native having been introduced by humans over time (Johnston, 1999). Neither NatureScot nor CIEEM provides guidance on determining the value of non-native species, so professional judgement and general guidance from the Invasive Non-native Species Framework Strategy for Great Britain has been used (DEFRA, 2015). This suggests that non-native species should not be considered as valuable or important ecological receptors. This approach was also used at the Viking Wind Farm, Beaw Field Wind Farm and Mossy Hill Wind Farm. SNH and Shetland Islands Council agreed with the intention to scope out non–native terrestrial mammal species within a Shetland context, with the exception of otter, which is a European Protected Species (EPS).

6.3.3 Marine mammals are considered separately in Chapter 10.

6.3.4 Consultation and best practice guidance identified key ecological surveys required to consider the potential impacts of the Proposed Project on ecology. These studies included:

- a natural heritage desk study;
- a Phase 1 Habitat survey;
- a National Vegetation Classification (NVC) survey;
- a Groundwater Dependent Terrestrial Ecosystem (GWDTE) survey;
- an otter survey; and,
- a freshwater pearl mussel survey.

6.3.5 Full details of ecological survey methodologies and results can be found in Appendices 6.1 to 6.4 inclusive.

6.4 Assessment Methodology and Significance Criteria

Consultation

6.4.1 In accordance with CIEEM best practice guidance, consultation with SNH/NatureScot was undertaken throughout the planning process for SaxaVord Spaceport. These surveys remain pertinent to the Proposed Project and have therefore been included in the AEE. As the Proposed Project environmental budget of ten launches per year makes up one third of that of the wider Spaceport; it was not considered necessary to undertake further consultation for this AEE.

Study Areas and Environmental Zone of Influence

6.4.2 The geographic definitions set out in Table 6.2 are used in this chapter and associated Appendices.

Table 6.2 – Site and Environmental Zone of Influence Definitions

Term	Definition
The site	This refers to all of the land within the Proposed Project boundary.
The Development Footprint	This refers to the footprint of the infrastructure within the SaxaVord Spaceport boundary.
The study area	The study area equates to the land within the Proposed Project boundary, plus an appropriate survey buffer. This can be variable depending on the ecological receptor and is described in the relevant appendices. As surveys were conducted as part of SaxaVord Spaceport planning application works, the habitats study area equates to the SaxaVord Spaceport site plus a ca. 100 meters (m) or 250 m buffer, excluding private properties and gardens. For otters the study area was the site plus a 500 m buffer. In this Chapter two study areas are referred to: ➢ The Habitats study area, which is the whole of the SaxaVord Spaceport site at Lamba Ness plus a 250 m buffer, for habitats and vegetation communities. ➢ The Otter study area, which is the whole of the SaxaVord Spaceport site at Lamba Ness plus a 500 m buffer, for otters. These are shown in Drawing 6.1.

6.4.3 These geographic areas combined are considered to be the ecological study area for the Proposed Project.

6.4.4 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicle from Launch Pad 3 at SaxaVord Spaceport Lamba Ness Launch Site (LNLS) in Unst, Shetland.

6.4.5 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage expendable liquid fuelled launch vehicle primarily comprised of a carbon fibre structure. The fuel for both stages is Liquid Petroleum Gas (LPG), and Liquid Oxygen (LOX) as the oxidiser. Helium (He) is utilised on both stages for pressuring the fuel and oxidiser tanks.

6.4.6 The Orbex PRIME Launch Vehicle is designed to launch payloads of up to 180 kg into both sub-orbital trajectories and sun synchronous orbits. The EZI for the Proposed Project is contained between 085 and 100 degrees from the equator. All launches will take place from Launch Pad 3 at SaxaVord Spaceport.

6.4.7 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year.

6.4.8 The main elements of the Proposed Project which have the potential to impact on ecological receptors during operation are described in Chapter 3 and comprise:

- Preparation of the Orbex PRIME Launch Vehicle;
- Storage and Handling of Launch Vehicle Propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of the Orbex PRIME Launch Vehicle (including discarded stage drop zones).

6.4.9 The ecological study area for any project is the area over which ecological receptors may be affected by biophysical changes as a result of the Proposed Project. The study area will vary for different ecological receptors depending on their sensitivity to, and nature of, an environmental change. The study area can extend beyond the site and required buffer areas, particularly in the context of hydrological connectivity and potential pollution events. However, the study area for each receptor is considered appropriate for the vast majority of ecological receptors. Downrange impacts outwith the ecological study area but within the EZI, such as returning component interaction with the marine environment, are considered in Chapter 10.

6.4.10 For habitats, the study area is defined as the Proposed Project site plus a buffer. The Proposed Project lies within SaxaVord Spaceport, for which the site Habitats study area has a 250 m buffer around the SaxaVord Spaceport boundary in accordance with SEPA's guidance for GWDTE assessments (SEPA, 2017).

6.4.11 Assessing the potential effects of disturbance on other ecological receptors, such as otters, is a more complex issue and varies depending on the type of disturbance (e.g., routine/predictable verses unusual/unexpected), topography, vegetation and the behaviour/tolerance of the receptor species and even different individuals within species.

6.4.12 For the SaxaVord Spaceport planning application, SNH's standing guidance on otter surveying (no date) stated that "otters could be affected by a development proposal anywhere in Scotland close to a water course, wetland, coastline or estuary. An otter survey should be carried out for any proposal within 200 m of these habitats". The updated NatureScot standing guidance issued subsequently (no date) provides the same advice. Whilst this is in accordance with best practice guidance e.g., Chanin (2003), the potential noise and vibration from the satellite launches could be considerable. Consequently, this 200 m survey buffer was not necessarily considered an adequate basis on which to determine the size of the Otter study area.

6.4.13 There is no standard guidance on potential disturbance (and so survey) distances for satellite launches and so in the planning application and followed through into the SaxaVord Spaceport AEE and this subsequent AEE, a precautionary approach to determining the size of the study area has been adopted in line with CIEEM (2018) best practice guidance.

6.4.14 Given the lack of any empirical evidence or guidance on the potential impact of satellite launches on otters, it was decided that at least doubling the standing guidance for determining survey area, from a 200 m to a 500 m buffer was a legitimate precautionary basis on which to proceed with otter surveys. Consequently, the size of the Otter study area (Drawing 6.1) is considerably larger than the either the Proposed Project boundary or the SaxaVord Spaceport boundary. The study area and is centred on indicative LNLS locations assessed during the SaxaVord Spaceport planning pre-application consultation discussions.

6.4.15 Surveys undertaken have continued where, in the professional judgement of the surveyor, otter signs may have occurred just outwith the Otter study area in potentially suitable and contiguous habitats e.g., along watercourses.

Survey Approach

6.4.16 A reconnaissance site visit by Dr Peter Cosgrove in late autumn 2017 determined that the Proposed Project area was predominantly open coastal/upland habitat characterised by peatland, grassland and sea cliffs (plus some buildings and associated hard standings). The principal land use was sheep grazing through crofting and common grazing.

6.4.17 The ecological surveys included a desk study of historical information sources and a series of targeted field surveys of potentially important and/or legally protected ecological receptors. All the ecology field surveys were undertaken by experienced ecological surveyors using recognised survey methods, during suitable times of year and under suitable weather conditions for the habitats and species concerned. Any departures from standard guidance are explicitly stated and reasons for the departure given.

Desk Study

6.4.18 An initial desk study was conducted in 2017 using the SNH’s SiteLink website and Shetland Biological Records Centre data held for the Search Area. This was supplemented by existing knowledge of Unst. Given the time gap between 2017 and the current planning submission, the exercise was repeated from the same data providers, alongside up to date information from the National Biodiversity Network (NBN) Atlas; a collaborative partnership created to exchange biodiversity information. This information was then compiled into a technical report in August 2020 (Appendix 6.1).

6.4.19 All known records of potentially important ecological receptors within at least a one kilometre (km) radius of the Proposed Project was identified. All designated sites with ecological qualifying features within a 10 km radius of the Proposed Project were also identified.

Field Surveys

Phase 1 Habitat Survey

6.4.20 A Phase 1 Habitat survey was conducted in July 2018 and updated in July 2020. The vegetation was described and mapped following the methods described in the Joint Nature Conservation Committee (JNCC) Handbook for Phase 1 Habitat surveys (JNCC, 2010), the revised field manual (JNCC, 2012). Details of the survey methodology and results are provided in Appendix 6.2. Whilst no systematic Phase 1 Habitat survey was undertaken in 2022, in line with best practice guidance, the Habitats study area was walked over during summer months by the same experienced habitat surveyor and no substantive changes were recorded other than the construction works commencing and so the 2018-2020 baseline survey and assessment was considered robust.

National Vegetation Classification (NVC) Survey

6.4.21 A NVC survey was conducted in July 2018 and updated in July 2020. The vegetation was classified and mapped following the methods described in the JNCC National Vegetation Classification User's Handbook (Rodwell, 2006). Details of the survey methodology and results are provided in Appendix 6.2. Whilst no systematic NVC survey was undertaken in 2022, in line with best practice guidance, the Habitats study area was walked over during summer months by the same experienced habitat surveyor and no substantive changes were recorded other than the construction works commencing and so the 2018-2020 baseline survey and assessment was considered robust.

Potential Groundwater Dependent Terrestrial Ecosystem (GWDTE) Survey

6.4.22 Wetland habitats were identified in July 2018 and updated in July 2020 as part of the Phase 1 Habitats and NVC vegetation surveys, in accordance with the Functional Wetland Typology (SNIFFER, 2009a, 2009b). Where wetlands were identified, an assessment was made as to whether they were likely to be potential GWDTEs as defined by SEPA (SEPA, 2017). Details of the survey methodology and results are provided in Appendix 6.2. Whilst no systematic GWDTE survey was undertaken in 2022, in line with best practice guidance, the Habitats study area was walked over during summer months by the same experienced habitat surveyor and no substantive changes were recorded other than the construction works commencing and so the 2018-2020 baseline survey and assessment was considered robust.

Peatland Condition Assessment (PCA)

6.4.23 A PCA was undertaken in July 2018 and updated in July 2020 as part of the Phase 1 Habitats and NVC vegetation surveys, in accordance with the Peatland Action Guidance (Peatland Action, 2016). Details of the assessment methodology and results are provided in Appendix 6.2. Whilst no systematic PCA was undertaken in 2022, in line with best practice guidance, the Habitats study area was walked over during summer months by the same experienced habitat surveyor and no substantive changes were recorded other than the construction works commencing and so the 2018-2020 baseline survey and assessment was considered robust.

Otter Survey

6.4.24 The Otter study area was surveyed under SNH licence for otters in 2018 and 2020 by Brydon Thomason, a highly experienced and locally based otter surveyor, with unparalleled practical experience of working on otters in Unst (Appendix 6.a).

6.4.25 A typical/standard otter survey often involves a single survey visit. However, otters are known to be seasonal in their use of certain habitats and so single visits can underestimate occupancy or seasonal use of an area. To ensure that a robust assessment of otter activity was undertaken and the use by otters understood, the Otter study area was surveyed during June and October 2018 and again in July 2020. A pre-construction otter survey (Appendix 6.3b) was undertaken in March 2022 by Donald Shields MCIEEM, a highly experienced mammal surveyor and ecologist. Surveys were undertaken around the Development Footprint and in suitable habitat within a 200 m buffer.

6.4.26 To maintain up-to-date otter data for the Spaceport, further otter surveys around the Development Footprint and in suitable habitat within a 200 m buffer were undertaken in July 2024 (Appendix 6.3c).

6.4.27 The survey methods for each survey followed standard best practice guidance and involved a systematic survey of terrestrial, aquatic and riparian habitats within the study areas looking for places' otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains or footprints). The otter surveys took place during suitable weather conditions, so that otter field signs (spraints, slides, sheltering or resting places etc.) would have had time to build up, be relatively visible and would not have been degraded/washed away e.g., after heavy rain. Details of the survey methodology and results are provided in Appendix 6.3a. The pre-construction surveys undertaken in 2022 are provided as an addendum to the previous otter survey report (Appendix 6.3b) and provide an update on the otter European Protected Species baseline (Appendix 6.3a). The July 2024 otter survey is reported in Appendix 6.c. The existing 2018-2020 survey data and assessment is considered robust in light of the updated 2022 and 2024 survey data which demonstrates no substantial changes in the baseline conditions.

Freshwater Pearl Mussel Survey

6.4.28 The Burn of Norwick was surveyed by Dr Peter Cosgrove, an experienced and licensed freshwater pearl mussel surveyor in September 2018. Details of the survey methodology and results are provided in Appendix 6.4.

Assessment of Potential Effect Significance

6.4.29 This section defines the criteria that were used to evaluate the significance of predicted likely effects on important ecological receptors due to the Proposed Project. A level of confidence or likelihood (whether the predicted effect is certain, likely, possible or unlikely) is attached to the predicted effect.

Evaluating Conservation Importance

6.4.30 The ecological receptors identified in the baseline studies were evaluated following best practice guidelines (e.g., CIEEM, 2018). Identifying the importance of potential ecological receptors was the first step of the process, and those considered potentially important, and present were then subject to more detailed survey and assessment. Those considered sufficiently widespread, unthreatened and resilient to the project impacts were scoped out of further assessment as per best practice EcIA guidance (e.g., CIEEM, 2018).

6.4.31 Ecological receptors can be important for a variety of reasons and the rationale used to define their importance has been explained to demonstrate a robust selection and evaluation process. Importance may relate, for example, to a designated site, to species rarity, to the extent to which they are threatened throughout their range, or to their rate of decline. Various characteristics contribute to the potential importance of ornithological receptors within an area. Examples include:

- naturalness;
- animal or plant species, sub-species or varieties that are rare or uncommon, either internationally, nationally or more locally, including those that may be seasonally transient;
- ecosystems and their component parts, which provide the habitats required by important species, populations and/or assemblages;
- endemic species or locally distinct sub-populations of a species;
- habitats that are rare or uncommon;
- habitats that are effectively irreplaceable;
- habitat diversity;
- size of habitat or species population;
- habitat connectivity and/or synergistic associations;
- habitats and species in decline;
- rich assemblages of plants and animals;
- large populations of species or concentrations of species considered uncommon or threatened in a wider context;
- plant communities (and their associated animals) that are considered to be typical of valued natural/semi-natural vegetation types, including examples of naturally species-poor communities; and,
- species or habitats on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change.

6.4.32 Guidance on EcIA also sets out categories of ecological or nature conservation importance that relate to a geographical framework (e.g., international through to local) together with criteria and examples of how to place a site or study area (defined by its ecological attributes) into these categories. It is generally straightforward to evaluate sites or species populations designated for their international or national importance (as criteria for defining these exist e.g., SAC and SSSI), but for sites or populations of regional or local importance, criteria may not be easily defined. Where possible, the potential importance of an ecological receptor in the site/study area has been determined within a defined geographical context using criteria outlined in Table 6.3.

Table 6.3 – Summary of Geographic Population Importance Criteria Used

Term	Definition
International	For example, >1% of European Community (EC) population/area of habitat
National	For example, >1% of United Kingdom (UK/Scotland) population/area of habitat
Regional	For example, <1% of United Kingdom (UK/Scotland) population/area of habitat, but >1% of regional resource (Shetland) population/area of habitat
Local	For example, within local area

6.4.33 It should be noted that there is no fundamental biological reason to take 1% of a population as the threshold level for establishing the level of geographical importance of a site. Nevertheless, this percentage is widely considered to be of value in developing measures that give an appropriate level of protection to populations and has gained acceptance on this basis throughout the world. The criterion was, for example, adopted by parties involved in the Ramsar Convention 1971. Thereafter, the 1% level of national species totals has been taken as the basis of assessment in various countries, including Britain (Stroud et al., 1990).

6.4.34 To be clear, the ecological importance afforded to a habitat or species within a site or study area is determined by both the geographical context, as well as the range of ecological characteristics of the habitat or species exhibit (listed above). For example, a habitat in any condition, which is >1% of the national total could be considered nationally important, whereas a habitat smaller than this, but considered to be of particular high quality (for example, meeting SSSI selection criteria) and/or are connected to/are a stepping-stone between designated sites may also be considered nationally important.

6.4.35 The importance attached to an ecological receptor can also be determined according to legislative status. Some ecological receptors are subject to a general level of legal protection through e.g., the Wildlife and Countryside Act 1981 (as amended), or The Nature Conservation (Scotland) Act 2004 (as amended) and others under Council Directive 1992/43/EEC of 21 May 1992 on the Conservation of Natural Habitats and of Wild Fauna and Flora (the so-called Habitats Directive). There is no clear guidance for conservation importance of ecological receptors other than those of European Protected Species and nationally designated site species and habitats. The importance of other species and habitats is based on professional judgement using the characteristics outlined above. The status of potentially important receptors, such as being on the SBL, is also taken into consideration.

6.4.36 Nevertheless, for the avoidance of doubt, CIEEM EcIA guidance (2018) makes it clear that species which appear on national lists e.g., Schedule 1 of the Wildlife and Countryside Act (1981 as amended) and SBL are not necessarily evaluated as of national importance simply by appearing on such a ‘national’ list. Importance evaluation must consider the number of individuals of species or area of habitat within a geographical context/scale, i.e., how many of a particular species are likely to be affected by the Proposed Project and what proportion of the local/regional/national population does this constitute. Legal listing/protection is a separate but important consideration.

6.4.37 Once the importance of an ecological receptor has been determined, the potential impacts on that receptor are considered in terms of magnitude, extent, duration, frequency and timing, reversibility, sensitivity and whether the impact would likely be beneficial, adverse or neutral.

Beneficial or Adverse

6.4.38 According to CIEEM (2018) beneficial (positive) and adverse (negative) impacts and effects should be determined according to whether the change is in accordance with nature conservation objectives and policy. In the CIEEM Guidance, the terms positive and negative are used, but in this chapter the equivalent terms beneficial and adverse are used, as synonyms, for consistency between Chapters. These terms are defined as:

- Beneficial – a change that improves the quality of the environment e.g., by increasing species diversity, extending habitat or improving water quality. This may also include halting or slowing an existing decline in the quality of the environment.
- Adverse – a change which reduces the quality of the environment e.g., destruction of habitat, habitat fragmentation, pollution.
- Impacts and effects can also be assessed as neutral.

Extent

6.4.39 According to CIEEM EcIA guidance (2018), extent is the spatial or geographical area over which the predicted impact/effect may occur under a suitably representative range of conditions.

Magnitude

6.4.40 According to CIEEM EcIA guidance (2018), magnitude refers to size, amount, intensity and volume. It should be quantified if possible and expressed in absolute or relative terms e.g., the amount of habitat lost, percentage change to habitat area, percentage decline in a species population. In this assessment there are considered to be four levels of magnitude of impact (Table 6.4) and it is assumed these are adverse, unless otherwise stated.

Table 6.4 – Summary of Magnitude Criteria Used

Term	Definition
Major	Total/near total loss of a population/habitat due to mortality or displacement. Total/near total loss of breeding productivity in a population due to disturbance. e.g., ≥50% of population/habitat affected.
Moderate	Moderate reduction in the status or productivity of a population/habitat due to mortality or displacement or disturbance. e.g., 10% to 49% of population/ habitat affected.
Minor	Small but discernible reduction in the status or productivity of a population/habitat due to mortality or displacement or disturbance. e.g., 1% to 9% of population/habitat affected.
Negligible	Very slight reduction in the status or productivity of a population/habitat due to mortality or displacement or disturbance. Reduction barely discernible, approximating to the ‘no change’ situation. e.g., <1% population/habitat affected.

Duration

6.4.41 According to CIEEM EcIA guidance (2018), duration should be defined in relation to ecological characteristics (such as the life cycle of a species). The duration of an activity may differ from the duration of the resulting effect caused by the activity. Impacts and effects may be described as short, medium or long-term and permanent or temporary and should be defined. In this assessment three timeframes are used: short-term (up to two years), medium-term (two-five years) and long-term (between five years and the lifetime of the Proposed Project).

Frequency and Timing

6.4.42 According to CIEEM EcIA guidance (2018), the number of times an activity occurs may influence the resulting effect. For example, a single person walking a dog will have very limited impact on nearby otters using wetland habitat, but numerous dog walkers will subject the otters to frequent disturbance and could affect breeding/feeding success, leading to displacement and knock-on effects on their ability to survive. The timing of an activity or change may result in an impact if it coincides with critical life-stages or seasons.

Reversibility

6.4.43 According to CIEEM EcIA guidance (2018), an irreversible effect is one from which recovery is not possible within a reasonable timescale or there is no reasonable chance of action being taken to reverse it. A reversible effect is one from which spontaneous recovery is possible or which may be counteracted by mitigation. In some cases, the same activity can cause both reversible and irreversible effects.

Sensitivity

6.4.44 Another factor when assessing potential impacts is the behavioural sensitivity of the ecological receptor under consideration (e.g., high, medium or low) and the zone of influence. Different receptors respond differently to stimuli, making some particularly sensitive to development activities and others less so. Professional judgement is used when assigning sensitivity to an ecological receptor and this is recorded here in a clear and transparent way. Sensitivity criteria vary across the wide range of taxonomic groups considered in an ecological impact assessment and are therefore provided in the receptor descriptions of this chapter.

6.4.45 By way of example, sensitivity is determined according to species' behaviour, using broad criteria set out in Table 6.5. Behavioural sensitivity can differ between species and between individuals of the same species. Therefore, sensitivity is likely to vary with both the nature and context of the disturbance activity as well as the experience and even 'personality' of the species, in the case of mammals. Sensitivity also depends on the activity the species is undertaking and when it is doing it. For example, a species is likely to be less tolerant of disturbance during the breeding season than at other times of the year. Thus, sensitivity changes with both space and time.

Table 6.5 – Summary of Sensitivity Criteria Used

Term	Definition
High	Species occupying remote areas away from human activities or exhibiting strong and long-lasting reactions to disturbance events. Habitats that are considered to have a slow recovery time to disturbance.

Term	Definition
Medium	Species that appear to be warily tolerant of human activities or exhibiting short-term reactions to disturbance events. Habitats that are considered to have a moderate recovery time to disturbance.
Low	Species occupying areas subject to frequent human activity and exhibiting mild and brief reaction to disturbance events. Habitats that are considered to have a quick recovery time from disturbance.

Likelihood

6.4.46 Finally, a level of confidence (whether the predicted impact is certain, likely, possible or unlikely) can be attached to a predicted effect.

Criteria for Evaluating Significance

6.4.47 Significance is a concept related to the weight that should be attached to predicted effects when decisions are made. A "significant effect"' is an effect that either supports or undermines biodiversity conservation objectives for important ecological features or for biodiversity in general. (CIEEM, 2018). There could be any number of possible impacts on important ecological features arising from a development. However, it is only necessary to describe in detail the impacts that are likely to be significant. Impacts that are either unlikely to occur, or if they did occur are unlikely to be significant, can be scoped out.

6.4.48 In the context of AEE, each likely effect is evaluated and classified as either significant or not significant, using professional judgement, evidence and best practice guidance. In this assessment, a significant effect is defined as '*impacts on the structure and function of defined sites, habitats or ecosystems and the conservation status of habitats and species (including extent, abundance and distribution) Significant effects should be qualified with reference to an appropriate geographic scale'*. Thus, the geographical terms of reference at which a predicted effect may be considered significant must also be defined (e.g., an effect on a species population evaluated to be of regional importance at a given site is likely to be either significant or not at the regional level). Effects can be considered significant at a wide range of scales from international to local.

6.4.49 There is sometimes confusion over geographical context, potentially important receptors and quantifying predicted effects and EcIA best practice guidance has often struggled to articulate this clearly. For example, if a potentially important species appears on a conservation list e.g., the SBL and there is a predicted impact, the geographical context in which the receptor is found must be considered. Therefore, the simple presence of a species on the SBL within an area does not mean that likely effects are significant at the national (Scottish) level. For that to occur, the Proposed Project must have significant effects on its national (Scottish) population.

Requirement for Mitigation

6.4.50 Best practice guidance (e.g., CIEEM, 2018) identifies a hierarchy of mitigation for potential impacts that seeks to:

- Avoid adverse ecological impacts, especially those that could be significant to important receptors.
- Minimise adverse impacts that could not be avoided.
- Compensate for any remaining significant residual impacts.

6.4.51 CIEEM guidance (2018) states that: ‘Avoiding and/or minimising negative impacts is best achieved through consideration of potential impacts of a project from the earliest stages of scheme design and throughout its development’. This approach to avoiding potential adverse impacts within a design layout is sometimes described as embedded mitigation or mitigation by design. ‘Mitigation by design is particularly beneficial as there is greater certainty that it will be delivered.’ (CIEEM, 2018).

6.4.52 There is now clear policy and guidance that development plans should not just try to avoid causing likely significant effects but aim to provide biodiversity enhancement (e.g., NPF4). Best practice guidance recommends seeking to provide enhancement for important biodiversity over and above design requirements for avoidance, minimisation or compensation (e.g., CIEEM, 2018; NPF4, 2023).

6.4.53 This chapter considers mitigation in the context of CIEEM guidance and also in relation to local planning authority guidance for protected species. The embedded mitigation has been considered in the design layout of SaxaVord Spaceport and because of this, has been guaranteed through planning conditions for the same. Where likely significant effects are predicted regardless of design layout, further mitigation is separately identified as per CIEEM best practice guidance.

Assessment of Residual Effect Significance

6.4.54 After assessing the potential impacts of the Proposed Project (incorporating embedded mitigation), all attempts were made to further avoid and mitigate predicted adverse ecological impacts. Once measures to avoid and mitigate predicted ecological impacts had been incorporated, assessment of the residual impacts was undertaken to determine the likely significance of their effects on important ecological features.

Limitations to Assessment

6.4.55 Where assumptions within the assessment are made, these are explicitly identified and explained. Similarly, limitations in methods and knowledge of species' ecology are also identified and discussed, particularly where this is likely to affect the outcome of the assessment. As with any environmental assessment there will be elements of uncertainty. Where there is uncertainty, this is identified and reported transparently, along with the measures taken to reduce it, assumptions made, and an explanation as to the likely extent that any uncertainties are likely to affect the conclusions. In circumstances where there is uncertainty; evidence, expert opinion, best practice guidance and professional judgement have been used to evaluate what is biologically likely to occur if the Proposed Project becomes operational.

6.4.56 The level of certainty of impact prediction varies depending upon a range of parameters discussed already. For some elements e.g., land-take it is relatively straightforward to assess and quantify the area of habitat that is likely to be lost to development infrastructure and therefore quantify potential impacts of land-take on the habitats present. However, other impacts are less certain because there can be a range of possible scenarios. The main limitations in this assessment are common to most ecological assessments because:

- Baseline surveys undertaken are based on sampling techniques, not absolute censuses. Results give an indication of the numbers of ecological receptors recorded at the particular times that surveys were carried out e.g., summer 2018, 2020, 2022 and 2024. Species occurrence changes over time and therefore the results presented in this AEE Report are snapshots in time. Importantly, no information gaps were identified in the baseline survey data that would prevent assessments in line with the requirements of the AEE to be undertaken. This limitation has been reduced by having a series of surveys repeated over a number of years (2018-2024).

- Putting ecology survey results into a wider geographical context is sometimes challenging because most species and habitats have not been systematically surveyed beyond the study area. Thus, defining a receptor population as locally or regionally important is potentially difficult because local or regional population estimates do not exist for most taxa and habitats. Whenever such uncertainty exists, professional judgement and published evidence is used and populations in the study area or site have been assumed to be at their highest potential level of geographical/ecological importance.

6.5 Baseline Conditions

Desk Study – Designated Sites

6.5.1 A total of 10 designated sites with ecological qualifying features within a 10 km radius of the Proposed Project have been identified (Table 6.6; Drawing 6.2). There are a number of Local Nature Conservation Sites in Unst and these are listed in Table 6.7.

Table 6.6 – Biological Designated Sites within 10 km of the Proposed Project

Designated Site	Designation Type	Area (ha)	Distance (km) and Direction	Biological Qualifying Features
Hermaness, Saxa Vord and Valla Field	SPA	6,832 ha	2.0 km, north-west	Breeding birds: • Fulmar *(Fulmarus glacialis)* • Gannet *(Morus bassanus)* • Great skua *(Stercorarius skua)* • Guillemot *(Uria aalge)* • Kittiwake *(Rissa tridactyla)* • Puffin *(Fratercula arctica)* • Red-throated diver *(Gavia stellata)* • Shag *(Phalacrocorax aristotelis)* Breeding bird assemblages
Keen of Hamar	SAC	40 ha	6.0 km, south	Upland habitats: • Base rich scree • Dry heath Grasslands on soils rich in heavy metals
Keen of Hamar	SSSI	50 ha	5.9 km, south	Calaminarian grassland and serpentine heath Vascular plant assemblages

Designated Site	Designation Type	Area (ha)	Distance (km) and Direction	Biological Qualifying Features
Hill of Colvadale and Sobul	SSSI	809 ha	9.3 km, south	Arctic sandwort *(Arenaria norvegica)* Breeding birds: • Arctic skua *(Stercorarius parasiticus)* • Whimbrel *(Numenius phaeopus)* Breeding bird assemblages Calaminarian grassland and serpentine heath
Valla Field	SSSI	629 ha	7.9 km, south-west	Breeding birds: • Great skua Red-throated diver
Crussa Field and Heogs	SSSI	469 ha	5.5 km, south	Breeding birds: • Arctic skua • Whimbrel Breeding bird assemblages Vascular plant assemblages Calaminarian grassland and serpentine heath
Hermaness	SSSI	978 ha	5.9 km, west	Breeding birds: • Fulmar • Gannet • Great skua • Guillemot • Puffin Breeding seabird colony
Saxa Vord	SSSI	56 ha	4.5 km, west	Breeding birds: • Fulmar • Guillemot Breeding seabird colony
Norwick Meadows	SSSI	25 ha	1.9 km, south-west	Sand dune habitats Valley fen wetlands
Fetlar to Haroldswick	MPA	216,000 ha	4.3 km, south	Aggregation of breeding birds: • Black guillemot (Cepphus grylle) Horse mussel beds Circalittoral sand and coarse sediment communities Kelp and seaweed communities on sublittoral sediment

Table 6.7 – Local Nature Conservation Sites in Unst (Shetland Islands Council 2015)

Local Conservation Site	Primary Interest	Justification for Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site, and it is one of only a few sites in Shetland where harebell (*Campanula rotundifolia*) has been recorded.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Norwegian sandwort (*Arenaria norvegica*) and northern rock cress (*Arabis petraea*)

Desk Study – Species

6.5.2 Full details of the desk study are provided in Appendix 6.1. The desk study demonstrated that there are a large number of records of species of potential interest within vicinity of the site, including legally protected species, SBL species and locally important/rare species. Table 6.8 summarises the results of the desk study for species with potential ecological importance for the Proposed Project.

Table 6.8 – Species Identified as EPS, SBL Species or having Local Importance

Species Name	Common Name	Taxa	Listing	Closest Record	Year of Record
Lutra	Otter	Mammal	EPS, SBL	>700 m, Norwick	2002-2011
Celaena haworthii	Haworth's minor	Lepidoptera	SBL	Norwick and Saxa Vord Camp (not the site)	2017

Species Name	Common Name	Taxa	Listing	Closest Record	Year of Record
Eugnorisma glareosa	Autumnal rustic	Lepidoptera	SBL	Within Saxa Vord Camp (not the site)	2017
Hepialus humuli	Ghost moth	Lepidoptera	SBL	Near Northdale Road	2017
Xanthorhoe decoloraria	Red carpet	Lepidoptera	SBL	Within Saxa Vord Camp (not the site)	2017
Caloplaca britannica	Lichen	Lichen	SBL	Lamba Ness	2015
Leptogium britannicum	Lichen	Lichen	SBL	Lamba Ness	2015
Opegrapha areniseda	Lichen	Lichen	SBL	Lamba Ness	2015
Thelenella muscorum var. octospora	Lichen	Lichen	SBL	Lamba Ness	2015
Spergula arvensis	Corn spurry	Vascular plant	Nationally vulnerable	Northdale and near Saxa Vord Camp (not the site)	2012-2015
Mertensia maritima	Oyster plant	Vascular plant	LBAP. Near Threatened and Nationally Scarce and scarce in Shetland	Inner Skaw	2019

Field Surveys

Habitat Surveys

6.5.3 Full details of the methods and results of the Phase 1 Habitat and NVC surveys can be found in Appendix 6.2 and Drawings 6.3 and 6.4; with results summarised below. It should be noted that the results of these surveys are based on the Habitats study area for SaxaVord Spaceport, and whilst the survey data are relevant beyond the SaxaVord Spaceport Development Footprint, the habitats within the SaxaVord Spaceport Development Footprint, as described in these surveys, has subsequently been stripped of all vegetation during construction of SaxaVord Spaceport (

6.5.4

6.5.5 Figure 6.1).

Figure 6.1 Vegetation stripping at Lamba Ness, March 2022

6.5.6 The Habitats study area included distinctive maritime grasslands in the east of the LNLS, which had a range of pools. This transitioned into an area of wet modified bog dominated by purple moor-grass (*Molinia caerulea*). More westerly habitats were made up of wet modified bog/wet heath, which was dominated by heather (*Calluna vulgaris*), common cottongrass (*Eriophorum angustifolium*), and acid grasslands. In the north-west section of the Habitats study area transitioned into blanket bog habitats.

6.5.7 There were small areas of other habitats, including standing water, marginal vegetation at the edge of pools and saltmarsh perched within the coastal vegetation. The old military buildings and roads and other infrastructure were also mapped across the Habitats study area and often had distinct vegetation around them, enriched from the sheep that sheltered in them.

6.5.8 All the habitats within the Habitats study area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. Sheep were evident across the Habitats study area and the impacts of fertilisation, grazing and sheep lay-down areas were recorded. Drainage ditches, both very recently cut, and older, were also recorded in wet modified bog and wet modified bog/wet heath habitats. There were areas of naturally occurring haggs, within the blanket bog, which were likely to be exacerbated by sheep and subsequently wind erosion.

6.5.9 The list of Phase 1 Habitats mapped and described in the Proposed Project site Habitats study area along with the total area and the percentage of the study area are displayed in Table 6.9.

Table 6.9 – Phase 1 Habitats in the Habitats Study Area

Phase 1 Habitats	Area (ha)	% of Habitats Study Area
Wet modified bog/wet heath	30.5	26.1
Wet modified bog	28.2	24.2

Phase 1 Habitats	Area (ha)	% of Habitats Study Area
Coastal grassland	19.7	16.8
Semi-improved acid grassland	16.3	14.0
Unimproved acid grassland	7.3	6.2
Wet modified bog/wet heath/dry heath	6.5	5.6
Buildings and roads	1.8	1.5
Fen	1.5	1.3
Blanket bog/bare peat	1.5	1.3
Blanket bog	1.1	1.0
Dry dwarf shrub heath	0.7	0.6
Saltmarsh	0.4	0.3
Wet modified bog/wet heath/bare peat	0.3	0.2
Sand dunes	0.3	0.2
Marginal and inundation	0.2	0.2
Wet modified bog/wet heath/acid flush	0.2	0.2
Bare ground	0.1	<0.1
Acid flush	0.1	<0.1
Bare peat	0.1	<0.1
Neutral grassland	0.1	<0.1
Standing water	<0.1	<0.1
Open vegetation	Too small to map separately	N/A
Water courses and drains	Mapped as lines	N/A

6.5.10 The NVC communities found within the Habitats study area were:

- Coastal grasslands
  - MC8d *Festuca rubra – Holcus lanatus* maritime grassland, *Holcus lanatus* sub-community
  - MC10a *Festuca rubra - Plantago spp.* maritime grassland, *Armeria maritima* sub-community
  - MC10b *Festuca rubra - Plantago spp.* maritime grassland, *Carex panacea* sub-community
  - MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community;

- Saltmarsh
  - SM16b *Festuca rubra* salt-marsh community, *Juncus gerardii* dominant sub-community;
- Sand dunes
  - SD4 *Elytrigia juncea* fore-dune community
  - SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community;
- Wet modified bog
  - M25b *Molinia caerulea – Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community
  - Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community
  - M3x *Eriophorum angustifolium* community;
- Fen
  - Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community;
- Semi-improved acid grassland
  - U4b *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland, *Holcus lanatus – Trifolium repens* sub-community;
- Unimproved acid grassland
  - U5a *Nardus stricta – Galium saxatile* grassland, species poor sub-community
  - U5b *Nardus stricta – Galium saxatile* grassland, A*grostis canina – Polytrichum commune* sub-community
  - U6 *Juncus squarrosus – Festuca ovina* grassland community;
- Neutral grassland
  - MG10a Ho*lcus lanatus – Juncus effusus* rush-pasture, typical sub-community;
- Wet dwarf shrub heath
  - M15d *Trichophorum cespitosum – Erica tetralix* wet heath, *Vaccinium myrtillus* sub-community
  - M15 *Trichophorum cespitosum – Erica tetralix* wet heath community;
- Blanket bog
  - M2b *Sphagnum cuspidatum/fallax* bog pool, *Sphagnum fallax* sub-community
  - M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire community;
- Bare peat
  - M3 *Eriophorum angustifolium* bog pool community;

- Dry dwarf shrub heath
  - H10b *Calluna vulgaris – Erica cinerea* heath, *Racomitrium lanuginosum* sub-community;
- Acid flush
  - M6b *Carex echinata – Sphagnum fallax* mire, *Carex nigra – Nardus stricta* sub-community;
- Open vegetation
  - OV25 *Urtica dioica – Cirsium arvense* community; and
- Standing water, water margins and inundation vegetation
  - S19a *Eleocharis palustris swamp*, *Eleocharis palustris* sub-community;
  - A22a *Littorella uniflora - Lobelia dortmanna* community, *Littorella uniflora* sub-community
  - A24 *Juncus bulbosus* community
  - OV28 *Agrostis stolonifera – Ranunculus repens* community.

Groundwater Dependant Terrestrial Ecosystems

6.5.11 Full details of the GWDTE survey and assessment can be found in Appendix 6.2 and Drawing 6.5. NVC communities recorded in the Habitats study areas that are considered in the guidance (SEPA, 2017) to be potentially groundwater dependent include:

- M6 *Carex echinata – Sphagnum fallax* mire;
- M15 *Trichophorum cespitosum – Erica tetralix* wet dwarf shrub heath;
- M25 *Molinia caerulea – Potentilla erecta* mire;
- MG9 *Holcus lanatus – Deschampsia cespitosa* grassland;
- MG10 *Holcus lanatus – Juncus effusus* rush-pasture;
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community; and
- U6 *Juncus squarrosus – Festuca ovina* grassland.

6.5.12 Those not in the guidance that are considered potentially GWDTE (due to their association with similar/related communities that are listed as potentially GWDTE), are:

- Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community; and
- M3x *Eriophorum angustifolium* community.

6.5.13 Of these, only M6 is considered to be potentially highly groundwater dependent, depending on the hydrological setting (SEPA, 2017). All the other communities are considered potentially moderately groundwater dependent, depending on the hydrological setting (SEPA, 2017). All mosaics of habitat were allocated their GWDTE category according to the NVC community with the highest potential GWDTE.

6.5.14 The bedrock for the majority of the Habitats study area was the Skaw Intrusion which was described as a '*low productivity aquifer*' with '*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*' (BGS, 2020). To the far west of the Habitats study area the bedrock is Hevda Phyllite Formation which was also described a '*low productivity aquifer*' with '*small amounts of groundwater in near surface weathered zone and secondary fractures*' (BGS, 2020). Therefore, the majority of the potentially GWDTE are considered most likely to be present due to waterlogged conditions sustained by high rainfall in the region, rather than groundwater for their maintenance.

6.5.15 The M6 community was located at the transition between the two bedrock types in the Habitats study area. This can be a source location for GWDTE, where groundwater is released at a spring or seepage line (McMullen, 2020). It is therefore considered that the M6 community may be an actual GWDTE.

6.5.16 Detailed geological and hydrological analysis of the SaxaVord Spaceport site determined that the potential GWDTE were either assessed as not being actual GWDTE or were >250 m from the Proposed Project (Appendix 6.5).

Peatland Condition

6.5.17 Full details of the peatland condition assessment (PCA) can be found in Appendix 6.2. The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the small area of bog habitat within the Habitats study area was clearly grazed and drained and there were patches of bare peat, using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Vascular Plants

6.5.18 Oyster plant, which was recorded in the fore-dune community within the Habitats study area, is an LBAP species and considered Near Threatened and Nationally Scarce and scarce in Shetland.

6.5.19 No other species recorded during field surveys were identified as being on the SBL, an LBAP species or in the lists of rare and scarce species for Shetland (Scott *et al*., 2002).

6.5.20 There was no evidence of any notifiable non-native invasive species within the Habitats study area during walkover surveys.

Lower Plants

6.5.21 No lower plant surveys were requested by SNH or conducted as part of the EcIA for the SaxaVord Spaceport planning application. However, lichen and bryophyte records identified as part of the desk study have been considered. Full details of the desk study are provided in Appendix 6.1. Table 6.8 summarises the results of the desk study and includes four lichen species which are on the SBL and were identified within the Proposed Project boundary.

Otters

6.5.22 Numerous otter field signs were recorded during targeted surveys in June and October 2018. Based on 2018 survey data, there were eight-ten otter holts within the Otter study area, with six-seven of these within the site (Drawing 6.6).

6.5.23 In 2020, additional otter surveys were undertaken at the Proposed Project Site. Numerous otter signs were recorded (Drawing 6.7). This included eight holts, located in boulder scree and on the boulder beaches, above the high tide mark. The holts were in inaccessible locations, between boulder or going into caves/crevices and were viewed from the cliff tops with binoculars. Scats and regularly used runs were recorded at the holt sites, and otters occasionally seen/heard. One particular holt on Lamba Ness, which had a large build-up of scats, was clearly being used by a female and her young in July 2020. Three otter holts were recorded in the 2022 pre-construction surveys.

6.5.24 Scats and footprints, including those of adults and young, were also recorded in the abandoned buildings across Lamba Ness. It was considered likely that some of the buildings were used as lay-ups during poor weather conditions and the predated remains of several fulmars (Fulmarus glacialis) were also noted within the buildings. Similar evidence of otter use was recorded in the 2022 pre-construction surveys.

6.5.25 Otter use of an underpass at HP 671 154 was particularly noticeable. It was considered likely that otters use this underpass as a regular route to cross from the north to south side of Lamba Ness. The route was well delineated on the grassland and rocks showing a well-established run and so was functionally important to otter use of the Lamba Ness area.

6.5.26 The data from 2020 indicated that there was one female with young using Lamba Ness as their home territory. Regular sightings of a male indicated that Lamba Ness also formed part of at least one, if not two, dog otter territories. Evidence of otter activity was also recorded in the 2022 pre-construction surveys.

6.5.27 In the 2024 otter surveys, it was reported that 'the site remains similarly active as previous visits with pretty much all previous spraint points or potential hots, showing signs of usage over recent days/weeks. As with previous surveys, all presumed holt sites were at base of cliffs, amongst large bolder scree clear of high-water mark. This usage of hots/lay-up/resting places are very typical to this type of coastline during the relatively calmer sea states of summer months.

None of the holts or presumed holts identified showed signs of usage that would suggest natal holt usage, however due to the seasonal preference for breeding, that could well change at any given time, particularly as we approach autumn.

The known otter run, which uses the underpass near the point of Lamba Ness, remains active and an important crossing point for otters. The increased site works traffic here does not appear to have deterred Otters from using this clearly important feature.

Historic bunkers on Lamba Ness are still being used by otters, presumably as resting places, though no bedding was found.'

6.5.28 An otter licence has been granted from NatureScot which extends from January 2025 until December 2029 (License No. *280355*). The licence permits temporary disturbance of otters in the vicinity of the site, with all works being undertaken in accordance with the Otter Protection Plan (Appendix 6.3c).

Freshwater Pearl Mussels

6.5.29 The Burn of Norwick was surveyed, under licence, for freshwater pearl mussels in September 2018. No evidence of freshwater pearl mussels was found in the Burn of Norwick survey reach. No patches of suitable or potentially suitable substrate habitat were recorded in the Burn of Norwick survey reach. There was no evidence of freshwater pearl mussel presence within the Burn of Norwick survey reach. Consequently, the survey evidence suggests that there are no special freshwater pearl mussel sensitivities that need to be considered.

6.6 Receptors Brought Forward for Assessment

Potentially Important Ecological Receptors

6.6.1 Ecological features/receptors can be important for a variety of reasons and the rationale used in evaluation should be explained to demonstrate a robust and transparent selection process (CIEEM, 2018). Based on the results of the desk study, initial site walkover, field surveys, consultation and feedback from the regulators, legal protection and professional judgement, the following potentially important receptors were identified for further consideration:

- designated sites;
- semi-natural habitats; and
- otter.

6.6.2 No other potentially important ecological receptors on which potentially significant effects were likely to occur were identified for further consideration. Other species (such as those identified in the desk study, cited as part of nearby designated areas with similar habitats to the study area or present in the LBAP), were mainly scoped out of further consideration on the basis of:

- recent survey results;
- habitats within the study area (e.g., coastal grassland) compared to the species' preferred habitat; and
- the population size of the potentially important species on a geographical basis.

6.6.3 Table 6.10 summarises the evaluation of potentially important receptor population/feature within the Proposed Project ecological study area/EZI.

Table 6.10 – Summary Evaluation of Potentially Important Ecological Receptors

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population / Feature within Study Area
Designated sites	Nationally important designated sites <750 m from the study area. Norwick Meadows, is taken forward for assessment.
Otter	Legally protected species. Evidence of regular and frequent use of the study area, with numerus field signs and multiple holts around the Otter study area. Otter's use is likely to include at least one male and one female, sometimes with young, around the Otter study area. Otters are considered to have moderate sensitivity to human activities, with resting places and holts considered highly sensitive. However, in Shetland, otters tolerate and utilise a wide variety of

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population / Feature within Study Area
	human-built features, such as buildings, ferry terminals and fish farms. Status: Stable in Scotland. GB population estimate unknown (Mammal Society, 2020). Scottish population considered to be flourishing, with an estimate of ca. 8,000 individuals (JNCC, 2019; SNH, 2020). Shetland population estimate 700-900 (Kruuk et al., 1989) – but note the age of this population estimate data and subsequent national population increase (30 years +). The study area is estimated to hold ca. 0.5% of the Shetland population. The site population is therefore considered locally important. The ecological receptor, otter, is taken forward for assessment.
Semi-natural habitats	Local, regionally, nationally and internationally important habitats present in Shetland. Some of the habitats described within the study area are similar to, or approaching descriptions for, Annex 1 habitats and/or SBL habitats. These include: ➢ coastal grasslands; ➢ saltmarsh; ➢ sand dunes; ➢ wet modified bog; ➢ wet modified bog/blanket bog; ➢ blanket bog; ➢ dry dwarf shrub heath; ➢ acid flush; and ➢ water margin vegetation. Within the study area, the quantity/quality of semi-natural habitats evaluated as locally important, except for some of the water margin vegetation and the sand dune vegetation. For full details of these evaluation refer to Appendix 6.2. These habitats are taken forward for assessment.
GWDTE	Potentially important GWDTE habitats present in the vicinity of the study area. All the potential GWDTE were assessed as not being actual GWDTE and/or were >250 m from the Proposed Project (Appendix 6.5). Therefore, GWDTE have been scoped out of further consideration.

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population / Feature within Study Area
Freshwater pearl mussels	Legally protected species. Status: Listed as Critically Endangered in Europe by IUCN. Scotland population declining; extinct in 73 rivers, not recruiting in 44 rivers and recruiting in 71 rivers (Cosgrove et al., 2016). Although present in Shetland (Cosgrove and Harvey, 2005), there was no evidence of freshwater pearl mussels, or potentially suitable habitat, in the Burn of Norwick during targeted surveys in 2018. Furthermore, all extant pearl mussel populations in Scotland have headwater lochs/lochan, Burn of Norwick does not have a headwater loch/lochan. Therefore, freshwater pearl mussels have been scoped out of further assessment.
Plants	<u>Oysterplant</u> LBAP species. Considered Near Threatened and Nationally Scarce and scarce in Shetland. Distributed around the coast of northern Britain. Population increased in north, but declined in south (Preston et al., 2002). Only found on gravelly beaches and shingle, and sometimes sand. This species was located on the fore-shore community at Inner Skaw. The dunes and fore-shore community at Inner Skaw are being avoided by the design layout. Therefore, this species has been scoped out of further assessment.
Lichens	The desk study identified four species of lichen, which have been recorded within close vicinity of the Proposed Project, that are SBL species (“watching brief only” category). <u>*Caloplaca britannica*</u> is considered rare in the UK (SBL, 2013). It is distributed widely around the coast of the UK and is of Least Concern according to the GB Red List (NBN Atlas, 2020) This species *‘is found on coastal rocks, in the spray zone and is undoubtedly under-recorded’* (Images of British Lichens, 2013). In Shetland it is known to be located in ‘*sheltered crevices in landward-facing rock face’*(Dalby and Dalby, 2005). <u>*Leptogium britannicum*</u> is found on coastal rocks (Images of British Lichens, 2013). It is distributed widely on the west coast of the UK and on Shetland and Orkney and is of Least Concern according to the GB Red List (NBN Atlas, 2020). In Shetland it is known to be located within amongst mosses in salt marshes and on cliffs (Dalby and Dalby, 2005). <u>*Opegrapha areniseda*</u> is considered rare in the UK. It is found on *‘slightly acid or neutral soft rocks near the seashore (schists) and mainly on old walls, notably of chapels’* (Maritime Lichens, 2020). It is distributed widely around the coast of the UK and is of Least Concern according to the GB Red List (NBN Atlas, 2020). This lichen species was not included in the Lichens of Shetland reference (Dalby and Dalby, 2005).

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population / Feature within Study Area
	Thelenella muscorum var. octospora is considered rare in the UK (SBL, 2013). No information was found on the UK habitat requirements for this lichen, and it has limited records in the UK with only 20 records on the NBN Atlas, although these are spread across England, Wales, Ireland and Scotland. This species is considered circumboreal, and is found across western United States, western Canada, UK, Ireland, Scandinavia, Europe and Russia (Christy et al., 2010). The habitat requirements that are reported in the United States are not consistent with the habitats found on Lamba Ness. It is considered that it is an obscure, under recorded and under researched species. The record on Lamba Ness describes the habitat it was found in as '*Coastal rocks, mainly granite, turf edge on cliff top*'. This species is not legally protected and is has not been evaluated by the GB Red List (NBN Atlas, 2020). The closely related lichen species Thelenella muscorum is distributed widely across the UK. This lichen species was not included in the Lichens of Shetland reference (Dalby and Dalby, 2005). It is considered unlikely that the three common species, which are of Least Concern, are widely distributed in the UK and were not mentioned by SNH in consultation, would be significantly impacted though the Proposed Project because: ➢ the relatively small number of records compared to the wide distribution of their under-recorded UK population; ➢ the study area is not designated or specially protected for these species, or habitats which support these species; ➢ they are located in habitat(s) which appear to be largely or wholly avoided by the design layout (e.g., namely coastal cliffs); and, ➢ ambient sulphur dioxide levels (the air pollutant which lichens are generally sensitive to) will not be impacted by the operation of the Proposed Project (Chapter 7). Therefore, these species have been scoped out of further assessment. These assessments are likely to also be relevant to the more obscure species *Thelenella muscorum var. octospora*. Additionally, the edge of the cliff, where this species was reported as being situated, is avoided by design. Therefore, it has also been scoped out of further assessment. Nevertheless, it is recognised that the ecological requirements of these poorly known species are not well understood. It should also be recognised that the distribution of some species can be poorly understood, particularly those in less widely known taxonomic groups, such as lichens. Where systematic surveys have not been widely undertaken know distributions may not fully reflect actual distribution and may be associated to where these species

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population / Feature within Study Area
	have been visited by specialist observers. This is a well know limitation of species distribution data.
Lepidoptera	Four species of Lepidoptera identified as part of the Desk Study which are all SBL species ('*watching brief only*' category). The four species were recorded within the vicinity of the Proposed Project. Haworth's minor (*Celaena haworthii*) is *'mainly a moorland species, occurring most commonly in northern England, Wales and Scotland... Cotton-grass (Eriphorium spp.) is the main foodplant, the larvae feeding internally on the stems'* (UK Moths, 2020). Distributed widely across the UK, more common in the north (Hill et al., 2010; Butterfly Conservation, 2020). Considered local (only found in some areas) (Butterfly Conservation, 2020). Resident in Shetland (Nature in Shetland, 2020). Autumnal rustic (*Eugnorisma glareosa*) inhabits *'woodland fringes, moorland and sandy or chalky soils, it is widely distributed, though not always common, throughout Britain. The adults fly in August and September, and the caterpillars are polyphagous, living on a wide variety of plants and grasses'* (UK Moths, 2020). Distributed widely across the UK (Hill et al., 2010). Considered common (NatureSpot, 2020). Resident in Shetland (Nature in Shetland, 2020). Ghost moth (*Hepialus humuli*) is considered a *'common species over much of Britain... The adults fly during June and July. The larvae feed underground on the roots of grasses and small plants'* (UK Moths, 2020) including nettles (Urtica dioica) and dock (Rumex spp) (Butterfly conservation, 2020). Distributed widely across the UK (Hill et al., 2010; Butterfly conservation, 2020). Considered common (Butterfly Conservation, 2020). Resident in Shetland (Nature in Shetland, 2020). Red carpet (*Xanthorhoe decoloraria*) *'A locally common species in northern Britain, occurring from Shropshire and Staffordshire northwards, into Scotland, where a local subspecies hethlandica occurs on the Shetland Isles... The favoured habitat is rocky moorland, where the larvae feed on lady's mantle Alchemilla spp., possibly also on other low plants'* (UK Moths, 2020). Distributed across northern Britain (Hill et al., 2010). Considered common (Butterfly Conservation, 2020). Resident in Shetland (Nature in Shetland, 2020). It is considered unlikely that these, generally common and widespread species, which were not mentioned by SNH in consultation, would be significantly adversely impacted though the Proposed Project because: - the relatively small number of records compared to the wide distribution of their under-recorded UK population;

Potentially Important Receptor	Evaluation of Potentially Important Receptor Population / Feature within Study Area
	➢ the study area is not specially designated for these species, or habitats which support these species; and ➢ other than a potentially small (negligible) land-take of possible habitat, no significant impacts are considered likely from the Proposed Project on these species. Therefore, these species have been scoped out of further assessment.

6.7 Standard Mitigation

6.7.1 In line with best practice guidance (CIEEM, 2018), an iterative design approach has been taken and the design of SaxaVord Spaceport, and within that context the Proposed Project, has been amended to avoid or minimise impacts on ecological receptors as far as possible. As such, mitigation has been embedded within the design and layout of the infrastructure needed to carry out operation of the Proposed Project since Alba Ecology's first involvement in the project in 2017.

6.7.2 The three key mitigation hierarchy principles of EcIA (CIEEM, 2018; CAA et. al., 2021), namely avoidance first, followed by minimisation and finally by compensation, along with enhancement have all been considered.

Avoidance

6.7.3 According to CIEEM best practice guidance, adverse effects should be avoided or minimised through mitigation measures, either through the design of the project or subsequent measures that can be guaranteed. For example, through a planning condition. The baseline habitat surveys influenced SaxaVord Spaceport design, avoiding, wherever possible areas of higher ecological sensitivities.

6.7.4 Avoidance of ecological receptors has been achieved by the Proposed Project because there will be no direct impact on any habitat type from the Proposed Project as all works will take place within the existing design footprint of SaxaVord Spaceport.

Minimisation

6.7.5 There will be no direct impact on any habitat type from the Proposed Project as all works will take place within the existing design footprint of SaxaVord Spaceport, and as such no minimisation of effects is required.

Compensation and Enhancement

6.7.6 Where there are significant residual adverse ecological effects despite the mitigation proposed, these should, under EcIA guidelines, be offset by appropriate compensatory measures. This is not the case for the Proposed Project, and so no compensatory measures are proposed.

6.7.7 The SaxaVord Spaceport Habitat Management Plan (Appendix 5.3) identifies eight main objectives, six of which will have direct ecological benefits to the Proposed Project site and surrounding area. These include peatland restoration, creation of riparian broadleaf tree/scrub cover, coastal grassland management, wetland creation including creating new pools and the creation of artificial otter holts. Whilst the pools and wetland areas are under the auspices of ornithology mitigation, they will none the less have ecological benefits increasing the biodiversity and providing additional habitat for non-avian species e.g., invertebrates.

6.7.8 The Applicant is aware of the commitments made by SaxaVord Spaceport within the Habitat Management Plan and will operate the Proposed Project in accordance with applicable procedures developed by SaxaVord Spaceport.

6.8 Potential Effects

Impacts to be Assessed

6.8.1 The main elements of the Proposed Project which have the potential to impact on ecological receptors are assessed within this section. For full details of the Proposed Project refer to Chapter 3.

6.8.2 The potential impacts of the Proposed Project are outlined in Table 6.11. It should be noted that potential impacts in this table do not imply that they would occur, or that any resultant effects would be significant.

Table 6.11 – Summary of Potential Impacts on Ecology

Activity	Potential Ecological Impact
Launch Activities	Noise and vibrations resulting in disturbance.
Transportation of Orbex PRIME Launch Vehicle and associated materials.	Pollution and/or sediment release into watercourses. Mortality/disturbance from vehicles.

Effects on Designated Sites

6.8.3 There are 10 designated ecological sites within 10 km of the Proposed Project, as identified in Table 6.6. This is reduced to six when ornithological designations, which are addressed separately in Chapter 5, are excluded. It is further reduced to five designated sites if Marine Protected Areas, addressed in Chapter 10, are excluded.

6.8.4 The closest designated ecological site is Norwick Meadows SSSI supporting important sand dune and valley fen habitats. The flora in this designated site is considered *'floristically rich'* with several rare and scares species (NatureScot, 2020). The valley fen is *'one of the best and most extensive examples of mesotrophic (moderately nutrient-rich) marsh in Shetland'* (NatureScot, 2020). Norwick Meadows SSSI is considered nationally important with high sensitivity. No land-take will take place within this designated site, so no direct habitat loss of the designated site will occur.

6.8.5 When assessing impacts on designated sites it is important to consider whether the Proposed Project is likely to undermine the conservation objectives of the site, the condition of the site, or the conservation status of the species or habitats for which the site is designated (CIEEM, 2018). Consideration should also be given to whether any process or key characteristic will be removed or changed, whether there will be an effect on the nature, extent, structure and function of component habitats and if there is an effect on the average population size and viability of species (CIEEM, 2018).

6.8.6 The conservation objectives for the Norwick Meadows SSSI (taken from Norwick Meadows SSSI Site Management Statement, 2011) are:

- To maintain and enhance the extent and condition of fen and swamp communities.
- To maintain and enhance the extent and condition of open dune and dune grassland habitats.
- To ensure populations of nationally scarce and locally rare species are protected.

6.8.7 As there will be no land-take from the Norwick Meadows designated site, there will be no direct loss to the fen and swamp communities, open dune, or dune grassland and the nationally scarce and locally rare species will not be directly impacted. Therefore, no likely significant effects are predicted for Norwick Meadows SSSI.

6.8.8 Potential indirect impacts on Norwick Meadows could arise from pollution events, although it should be noted that Norwick Meadows is ca. 1.9 km away from the Proposed Project. Pollution prevention measures required by all launch operators using SaxaVord Spaceport are outlined in Appendix 6.5 which takes into account standard mitigation, in particular implementation of a suitable OEMP and appropriate storage and management of fuels and chemicals. Therefore, with the embedded mitigation inherent to SaxaVord Spaceport accounted for, the magnitude of change on designated site as a consequence of pollution from the Proposed Project is assessed as negligible. With the embedded mitigation, the indirect impact on designated as a consequence of pollution is considered to be unlikely, intermittent, temporary and short-term (event) to medium term (recovery) and no likely significant effects are predicted.

6.8.9 All the other terrestrial designated sites are >4.0 km away from the Proposed Project. Therefore, no land-take or changes to hydrology will take place within these designated sites, and no direct or indirect habitat loss will occur. No other route to impact on designated sites or their features are predicted. Consequently, no likely significant effects on designated sites are predicted.

Effects on Otters

6.8.10 The Proposed Project has the potential to adversely affect otter directly or indirectly in a number of ways:

- damage to watercourses by run-off, pollution and blocking of streams;
- mortality caused by vehicle traffic during preparations for and launch activities; and
- disturbance/damage to hearing caused by noise during launch activities.

6.8.11 Otters are a legally protected species, considered to have moderate sensitivity to human activities, with resting places and holts considered highly sensitive. The population of otters using the Proposed Project site is considered of local importance.

6.8.12 Baseline otter surveys were completed on multiple occasions during and subsequent to the SaxaVord Spaceport planning stage, in different seasons and years, and were conducted in a larger study area than is usual for surveys of this nature. Consequently, otter use of the Proposed Project site is relatively well understood.

6.8.13 Numerous otter field signs were recorded including scats, holts, footprints and lay-ups. In the most recent 2024 otter, spraint, resting places and holts were located in inaccessible boulder scree areas and on the boulder beaches around Lamba Ness. Spraints and footprints were also recorded in the abandoned military buildings in the Proposed Project site. These results were similar to the previous survey results.

6.8.14 Original baseline survey data indicated that there was one female using Lamba Ness as their (main) home territory. Regular sightings of a male indicated that Lamba Ness also formed part of at least one dog otter territory. This constitutes c. 0.5% of the Shetland otter population. The 2024 otter survey reported similar levels of otter activity as the pre-construction baseline.

6.8.15 The Proposed Project will not result in any land-take and so there will be no mechanism for physical damage or loss of holts, feeding and resting places. Likewise, there will be no mechanism for severance or loss of connectivity as a result of the Proposed Project as there will be no land-take or construction of any kind (see Chapter 3 for details). Therefore, the physical damage or loss of holts, feeding and resting places, severance and loss of connectivity have been scoped out of the assessment.

Damage to watercourses by run-off, pollution and blocking of streams

6.8.16 In the unlikely event that a serious pollution incident occurred, leading to a sudden pulse of pollutant that was not readily contained, the pollutant could enter the aquatic environment and affect otters directly e.g., by coating fur with oil or indirectly through damage to their prey species. However, taking into account the implementation of best practice pollution prevention measures required by all Launch Vehicle Operators at SaxaVord Spaceport (Appendix 6.5), it is considered highly unlikely that a serious pollution incident would occur. Therefore, it is considered highly unlikely that pollution would substantially affect otter foraging. The magnitude of potential impact caused by a pollution event for otter is assessed as negligible. With the embedded mitigation designed into SaxaVord Spaceport, the impact caused by a pollution event from the Proposed Project is considered to be unlikely, intermittent, reversible and short-term (event), with a medium-term recovery and no likely significant effects are predicted (Table 6.13).

Mortality caused by vehicle traffic

6.8.17 Vehicular traffic across SaxaVord Spaceport will be regular during the Proposed Project, meaning that individual otters would have a possibility (albeit very small) of being injured or killed. However, the existence of inbuilt SaxaVord Spaceport mitigation measures such as the enforced low vehicle speed limits (10 mph) will greatly reduce the likelihood of injury or death occurring during operation. Otter crossing road signs will be located at the entrance to SaxaVord Spaceport and at the frequently used otter run to further help prevent vehicle traffic mortality during operation. Consequently, the magnitude of impact of direct mortality from operation of the Proposed Project is assessed as negligible. With the embedded mitigation, impact of direct mortality from operation of the Proposed Project is considered to be unlikely, intermittent, irreversible and short-term and no likely significant effects are predicted (Table 6.13).

Disturbance caused by noise

6.8.18 At the time of the original otter survey, there were at least one dog otter and one female otter (sometimes with young), within the range of elevated noise levels predicted for the Proposed Project.

6.8.19 Table 6.12 outlines the modelled maximum predicted dB levels from launch of the SaxaVord Spaceport representative Launch Vehicle (SaxaVord RepLV) on otter. As described in Chapter 8, anticipated noise levels from the Orbex PRIME Launch Vehicle are significantly below those of the SaxaVord RepLV and therefore the SaxaVord RepLV data are considered to represent a conservative approach. The holts on Lamba Ness are in the 0 km to 0.5 km range, the holts located at Saxa's Kettle and Vadna Taing are in the 0.5 km to 1 km range. From launch, the noise would rapidly (i.e., a matter of a small number of seconds) build from baseline to maximum, followed by a fairly rapid decrease back to baseline (tens of seconds).

Table 6.12 – SaxaVord Spaceport Modelling Study – Maximum Predicted Decibel (dB) Levels at Otter Holts around Launch Pad 3

Individuals	Launch LAmax
0-0.5 km	120-130dB
0.5-1 km	100-110dB

6.8.20 Otters are considered moderately sensitive to human disturbance. Otters use acoustic communication in both antagonistic (blows, mewing and cries) and social (murmurs and two types of whistles) situations, with new-borns using 'twitters' to demand care (Gnoli and Prigioni, 1995). Therefore, it can be concluded that hearing is an important sense for otters. A study of otter hearing range demonstrated that at 80 dB, in air hearing ranged from 200 hertz (Hz) to 32 kilohertz (kHz) (Voigt et al., 2019). As the Orbex PRIME Launch Vehicle noise will be concentrated in the low frequencies, the frequencies will be audible to otters in the vicinity to the Proposed Project. Exposure to loud sounds can result in hearing impairment or loss. Mammals are unable to regenerate damaged auditory (cochlear) hair cells following damage from high levels of noise. Therefore, any potential damage to hearing as a result of the Proposed Project would be considered permanent and non-reversible.

6.8.21 A literature search conducted using freely available sources (e.g., google scholar, researchgate), returned few relevant results regarding the impact of loud noise on otter. Areas of high human disturbance (i.e., not loud noise) has been shown to adversely impact on otter populations (e.g., Cortés et al., 1998). This does not necessarily translate to infrequent very loud noises, and otters in Shetland are known to deliberately inhabit areas around ferry terminals and fish farms which have moderate-high levels of human disturbance and noise.

6.8.22 Anecdotal accounts described in the literature suggest loud noise can impact on otter behaviour. Sharp and sudden noises have been reported to cause instant flight to the nearest water. These effects on behaviour may continue after the noise that caused the reaction has ceased (e.g., Jeffries 1985).

6.8.23 There is no direct evidence to suggest that the short-lived noise caused by the launch of the Orbex PRIME Launch Vehicle would impact on, and adversely affect the success of, otters within the study area and there is also no threshold noise metric against which to compare potential effects on otters. The literature search did not identify any directly relevant noise studies on otters or potentially analogous species. Whether the pre-launch warning siren, followed by the low frequency rumble of the Orbex PRIME Launch Vehicle followed by a rapid decrease back to baseline will be sufficient to allow otters to cope with the noise is currently speculative. Nevertheless, it is considered likely that this warning would give otters warning to swim underwater or find refuge in a holt or shelter where noise levels experienced are likely to be reduced.

6.8.24 The 2024 survey reported similar activity levels of otter as the pre-construction baselines. This indicates that otters are continuing to use the site with the associated noise of construction and engine tests etc.

6.8.25 As part of SaxaVord Spaceport's ecological mitigation commitments a total of 10 artificial otter holts/shelters will have been provided to supply many suitable refuge locations for otters.

6.8.26 If a worst-case scenario is assumed, i.e., mortality of all the otters in the study area, this would constitute an adverse impact on a maximum of two to three otters out of the Shetland population of ca. 700 to 900 individuals, i.e., 0.3% to 0.4% of the regional population and 0.04% of the Scottish population. However, based on the likelihood that the pre-launch warning siren would allow otters to find refuge, with a reduction in noise in holts or shelters, this worst-case scenario seems an unlikely scenario. If no such adverse response took place, then 0% of the regional and Scottish otter population would be adversely affected.

6.8.27 The magnitude of potential impact, in the worst-case scenario, caused by mortality/loss of territory from noise disturbance, is negligible. In the worst-case scenario, the potential impact to otters caused by mortality/loss of territory from noise disturbance is considered to be possible, intermittent, irreversible and short-term and no likely significant effects are predicted (Table 6.13).

6.8.28 An otter licence has been granted from NatureScot which extends from January 2025 until December 2029 (License No. *280355*). The licence permits temporary disturbance of otters in the vicinity of the site, with all works being undertaken in accordance with the Otter Protection Plan (Appendix 6.3c).

Table 6.13 – Summary of Likely Predicted Impacts on Otter

Parameter	Pollution	Mortality from Traffic / Activities	Operational Disturbance
Beneficial / adverse / neutral	Adverse	Adverse	Adverse
Extent	Watercourse and coastal region around Lamba Ness	Site-wide	Site-wide
Duration	Event = short-term Recovery = medium-term	N/A	Short-term noise level, potential for long term hearing damage
Reversibility	Reversible – pollution prevention measures and incident kits will be used.	Irreversible	Irreversible

Parameter	Pollution	Mortality from Traffic / Activities	Operational Disturbance
Frequency	Intermittent	Intermittent	Intermittent
Probability	Unlikely	Unlikely	Possible
Magnitude	Negligible	Negligible	Negligible

6.8.29 In summary, with the implementation of the mitigation measures already undertaken by SaxaVord Spaceport, no likely significant effects are predicted for otters in relation to the Proposed Project. To ensure up-to-date information with regard to otters on and around the wider SaxaVord Spaceport site, an Otter Protection Plan will be ongoing during the licence period of the Proposed Project.

Effects on Semi-natural Habitats

6.8.30 Direct impacts from land-take on semi-natural habitats severance and indirect impacts through changes in hydrology are scoped out as there will be no change in the SaxaVord Spaceport design footprint and no additional land-take associated with the Proposed Project.

6.8.31 Potential indirect impacts on semi-natural habitats could arise from pollution events. Pollution prevention measures required by all launch operators using SaxaVord Spaceport are outlined in Appendix 6.5 which takes into account standard mitigation, in particular implementation of a suitable OEMP and appropriate storage and management of fuels and chemicals. Therefore, with the embedded mitigation inherent to SaxaVord Spaceport accounted for, the magnitude of change on semi-natural habitats as a consequence of pollution form the Proposed Project is assessed as negligible. With the embedded mitigation, the indirect impact on semi-natural habitats as a consequence of pollution is considered to be unlikely, intermittent, temporary and short-term (event) to medium term (recovery) and no likely significant effects are predicted (Table 6.14).

Table 6.14 – Summary of Predicted Impacts on Habitats for the Proposed Project

Parameter	Pollution
Adverse/ beneficial/ neutral	Adverse
Extent	Around the SaxaVord Spaceport Design Footprint (LNLS) and into watercourses and the sea
Duration	Short-term (event) – medium-term (recovery)
Reversibility	Temporary
Frequency	Intermittent
Probability	Unlikely
Magnitude	Negligible

6.8.32 The SaxaVord Spaceport Habitat Management Plan (Appendix 5.3) identifies eight main objectives, six of which will have direct ecological benefits to the Proposed Project site and surrounding area. These include peatland restoration, creation of riparian broadleaf tree/scrub cover, coastal grassland management, wetland creation including creating new pools and the creation of artificial otter holts. Whilst the pools and wetland areas are under the auspices of ornithology mitigation, they will none the less have ecological benefits increasing the biodiversity and providing additional habitat for non-avian species e.g., invertebrates.

6.9 Residual Effects

6.9.1 No likely significant effects are predicted on semi-natural habitats or otters in relation to the Proposed Project and therefore no mitigation is proposed. As a result of this the residual effects are identical to the pre-mitigation effects predicted.

6.10 Cumulative Assessment

6.10.1 Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location (CIEEM, 2018). This guidance goes on to say that *'developments to be included in the cumulative impact assessment should be in accordance with national guidance'*. NatureScot provides no advice or guidance in relation to the cumulative impacts of a spaceport.

6.10.2 CIEEM (2018) also states in relation to cumulative assessment that 'Information about developments within the zone(s) of influence may be available in other EcIAs, Local Plan documents, Marine Spatial Plans, Strategic Environmental Assessments (SEAs), Sustainability Appraisals (SAs), Water Framework Directive Assessments (WFDAs), and Habitats Regulations Assessments/Appraisals (HRAs), including "Natura Impact Statements" (NISs) / "Natura Impact Reports" (NIRs), "Information / Reports to Inform an Appropriate Assessment", "Shadow Habitats Regulations Assessments" and, for Nationally Significant Infrastructure Projects, "Reports on the Implications for European Sites" (RIES)'.

6.10.3 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent. As such, as far as the Applicant is aware, there are no like for like or similar projects within the ecological study area and therefore, no significant issues are likely to arise from developments other than SaxaVord Spaceport.

6.10.4 SaxaVord Spaceport has a proposed capacity for 30 launches per annum. The Proposed Project will account for 10 of those launches.

6.10.5 As detailed in Chapter 8, noise from launches of the Orbex PRIME Launch Vehicle is anticipated to be significantly less than that from the SaxaVord RepLV and therefore animals in close proximity to Launch Pad 3 will not be disturbed any more from the Orbex PRIME Launch Vehicle than from the SaxaVord RepLV. In addition, the Orbex PRIME specific launch vehicle dimensions, propellants used, stage weights, and payload weight(s) by comparison to the SaxaVord RepLV do not make any material difference to the significance of cumulative environmental effects on ecology.

6.10.6 Therefore, assuming operators are identified for the remaining capacity, the cumulative ecological effects of all 30 launches from SaxaVord Spaceport would be expected to be as documented in the SaxaVord Spaceport AEE:

6.10.7 'Cumulative effects can result from individually insignificant but collectively significant actions taking place over a period of time or concentrated in a location.' (CIEEM, 2018). This guidance goes on to say that 'developments to be included in the cumulative impact assessment should be in accordance with national guidance'. SNH/NatureScot provides no advice or guidance in relation to the cumulative impacts of a spaceport.

6.10.8 CIEEM (2018) also states in relation to cumulative assessment that 'Information about developments within the zone(s) of influence may be available in other EcIAs, Local Plan documents, Marine Spatial Plans, Strategic Environmental Assessments (SEAs), Sustainability Appraisals (SAs), Water Framework Directive Assessments (WFDAs), and Habitats Regulations Assessments/Appraisals (HRAs), including "Natura Impact Statements" (NISs) / "Natura Impact Reports" (NIRs), "Information / Reports to Inform an Appropriate Assessment", "Shadow Habitats Regulations Assessments" and, for Nationally Significant Infrastructure Projects, "Reports on the Implications for European Sites" (RIES)'.

6.10.9 The ecological study area is an equivalent to the potential 'environmental zone of influence' and as there are no existing or proposed developments within that area, no significant issues are considered likely to arise from inter-project additive or cumulative effects.

6.10.10 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. The interactions between noise and ecology have been identified and assessed within this chapter, and no other environmental topic are considered likely to give rise to potential intra-project cumulative effects.'

6.11 Summary

6.11.1 This chapter has:

- Established the baseline ecological conditions of the site using a desk-study and targeted ecological surveys (Phase 1 Habitat survey, NVC survey, GWDTE survey, otter survey and freshwater pearl mussel survey).
- Identified the potentially important ecological receptors likely to be affected by the Proposed Project namely designated sites, otters and semi-natural habitats.
- Assessed the ecological importance and sensitivity of designated sites, otters and semi-natural habitats.
- Evaluated the likely magnitude of predicted impact on these ecological receptors from the operation of the Proposed Project.
- Identified mitigation, including avoidance and minimisation of impacts on sensitive ecological receptors.

6.11.2 The assessment does not predict any likely significant ecological effects associated with the Proposed Project.

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Chapter 7 Air Quality

7. Air Quality

7. Air Quality

7.1 Introduction

7.1.1 This chapter considers the potential effects of the Proposed Project on local air quality. The Proposed Project is described in full detail in Chapter 3; however, the elements with the potential to affect local air quality can be summarised as follows:

- Preparation of Orbex PRIME Launch Vehicle;
- Storage and Handling of Orbex PRIME Launch Vehicle propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of Orbex PRIME Launch Vehicle.

7.1.2 The 2024 Sutherland AEE (submitted as part of Sutherland Spaceport Operator Licence application SR-APP-001254) assessed the potential effects of emissions from road traffic associated with launch events which were concluded to be negligible.

7.1.3 Peak vehicle movements associated with an Orbex PRIME Launch Vehicle event are within the envelope of peak numbers assessed as part of the SaxaVord Spaceport AEE which concluded that the potential effects at relevant ecological and human receptors were not significant. No further assessment of traffic impacts on air quality is included in this AEE.

7.1.4 Emissions from generators were assessed in the SaxaVord Spaceport AEE and concluded to be not significant.

7.1.5 The 2024 Sutherland AEE assessed the potential effects of launch vehicle emissions on human and ecological receptors. The pollutants included were nitrogen dioxide (NO_2), benzene (C_6H_6) and naphthalene ($C_{10}H_8$). The impacts were concluded to be not significant at human and ecological receptors, the majority of which were significantly closer to the launch pad than any sensitive receptors are to Lauch Pad 3 at SaxaVord Spaceport. These pollutants are not considered further in this AEE.

7.1.6 The 2024 Sutherland AEE did not include an assessment of impacts of emissions of carbon monoxide (CO) from an Orbex PRIME Launch Vehicle on human receptors. CO is the pollutant emitted with the highest mass per launch (see Appendix 7.1) and short-term exposure to CO can cause serious health effects. For these reasons and to provide consistency with previous AEEs conducted for launch operators associated with SaxaVord Spaceport, this chapter includes an assessment of the potential for emissions of CO from each Orbex PRIME Launch Vehicle to cause significant effects at receptors relevant for human health.

7.1.7 This chapter has been prepared by SLR Consulting Limited and should be read in conjunction with Drawings 7.1 to 7.4 and Appendix 7.1 in Volumes III and IV respectively.

7.2 Legislation, Policy, and Guidelines

Space Industry Act

7.2.1 The Space Industry Act (2018) regulates all spaceflight activities conducted in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a Spaceport in the UK; or
- provide range control services from the UK.

7.2.2 As the Applicant wishes to become a spaceflight operator and launch Orbex PRIME Launch Vehicles from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the Proposed Project.

Space Industry Regulations 2021

7.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Air Quality Legislation

7.2.4 The UK's legislation and regulatory regime, along with national, regional, and local planning policy play a key role in the prevention, control and minimisation of atmospheric emissions that are potentially harmful to human health and the environment. Air Quality Objectives (AQOs) are quality standards for clean air that are used as assessment criteria for determining the significance of any potential changes in local air quality resulting from development proposals. Relevant legislation and guidance documents have been reviewed and considered as part of this Air Quality Impact Assessment (AQIA).

European Legislation

7.2.5 The EU has published a Directive on Ambient Air Quality Assessment and Management which came into force in September 1996 (Directive 96/62/EC). This Directive is intended as a strategic framework for tackling air quality consistently, through setting European wide air quality limit values in a series of daughter directives, superseding and extending existing European legislation. The first four daughter directives were placed into national legislation. A new EU air quality directive (Directive 2008/50/EC) came into force in June 2008 and was transposed into The Air Quality Standards Regulations in England, Wales, Scotland, and Northern Ireland in

June 2010 (H.M Government, 2010). The Directive merged the four daughter directives and one Council decision into a single national directive on air quality.

National Legislation

7.2.6 The Environment Act 1995 (H.M. Government, 1995) required the preparation of a National Air Quality Strategy (NAQS) setting air quality standards and objectives for specified pollutants and outlining measures to be taken by local authorities through the system of Local Air Quality Management (LAQM) and by others to work in pursuit of the achievement of these objectives. The NAQS was published in 1997 and subsequently reviewed and revised in 2000, and an addendum to the Strategy published in 2002. The current Strategy was published in July 2007; (Defra, 2007).

7.2.7 The objectives which are relevant to local air quality management have been set into Regulations namely Air Quality (Scotland) Regulations 2000, Air Quality (Scotland) Amendment Regulations 2002 and Air Quality (Scotland) Amendment Regulations 2016 (Scottish Government, 2016), the latter of which introduces an additional statutory obligation for Scottish Local Authorities to comply with an annual mean objective for $PM_{2.5}$ to align with the World Health Organisation Guideline Value (WHO).

7.2.8 The air quality standards (AQSs) are set for the purpose of protecting human health, vegetation, and ecosystems from certain harmful atmospheric pollutants. The Scottish AQSs take account of the EU limit values and are either effectively identical, or more stringent. The AQS applicable to the pollutant considered in this assessment is shown in Table 7.1.

Table 7.1 - Air Quality Standards

Pollutant	Air Quality Standard	
CO	10 mg/m^3	Running 8-hour mean

Local Air Quality Management

7.2.9 Under Section 82 of the Environment Act (1995) (Part IV) Local Authorities (LAs) are required to periodically review and assess air quality within their area of administration under the system LAQM. This review and assessment of air quality involves considering present and likely future air quality against the objectives and reporting to the Scottish Government by means of an Annual Progress Report (Shetland Islands Council, 2024). If it is predicted that levels at sensitive locations where members of the public are regularly present for the relevant averaging period are likely to be exceeded, the LA is required to declare an Air Quality Management Area (AQMA). For each AQMA the LA is required to produce an Air Quality Action Plan (AQAP), the objective of which is to reduce pollutant concentrations in pursuit of the objectives.

7.2.10 There are currently no AQMAs within the Shetland Islands.

Relevant Guidance

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

7.2.11 The Department for Transport issued its document 'Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

7.2.12 The environmental objectives for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities*
- *Protect people and wildlife from the impacts of noise from spaceflight activities*
- *Protect the marine environment from the impact of spaceflight activities.*

Guidance for the Assessment of Environmental Effects

7.2.13 The CAA, with the UK Space Agency, the Department for Business, Energy and Industrial Strategy and the Department for Transport, issued guidance note '*CAP2215 Guidance for the Assessment of Environmental Effects*' in July 2021. The guidance sets out what is required by the regulator regarding assessment of environmental effects as part of a licence application under the Act.

7.2.14 The guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including population and human health, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- The AEE should explain what other environmental assessments have been conducted in relation to the proposed activities and whether they are being used in support of the AEE;
- Applicants for a launch operator licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be conducted in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including air quality.

Environmental Assessment Requirements and Guidance for Airspace Change Proposals

7.2.15 The CAA Environmental Assessment Requirements and Guidance for Airspace Change Proposals CAP 1616i (CAA, 2023) states that assessment of emissions on local air quality is required for any airspace change less than 1000 feet in altitude.

Air Quality Guidance

7.2.16 The assessment also uses the guidance documents listed below:

- The Technical Guidance LAQM.TG (22) for Local Air Quality Management, (Defra 2022);
- The Environmental Protection UK (EPUK) and Institute of Air Quality Management (IAQM), Land-Use and Development Control: Planning for Air Quality (Moorcroft and Barrowcliffe et al, 2017);
- The Environmental Protection Scotland (EPS) and Royal Town Planning Institute (RTPI) Scotland Delivering Cleaner Air for Scotland guidance (EPS and RTPI, 2017); and,

7.3 Consultation

7.3.1 Extensive statutory consultation on air quality was conducted during preparation and determination of the planning application for SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 7.2.

Table 7.2 - Consultation

Consultee	Summary of Response	Where addressed
Air Quality / Ian Taylor assistant EHO, Shetland Islands Council / 14/07/2020	Agreement on method to assess impacts of launch vehicle emissions from launch pad 1, closest to a residential receptor. Agreement on screening approach for transport emissions.	Section 7.4 and Appendix 7.1

7.4 Assessment Methodology and Significance Criteria

Scope of the Assessment

7.4.1 The scope of the assessment has included the following:

- Application of the method of assessment agreed in consultation with Shetland Islands Council during preparation and determination of the planning application for SaxaVord Spaceport, where the Proposed Project will be operated.
- Identification of study area and air quality sensitive receptors.
- Collection of baseline Carbon Monoxide (CO) concentrations at the Proposed Project.

- Collection of emissions data from Orbex for the launch emissions from a 19 m long Orbex PRIME Launch Vehicle.
- Development of representative modelled scenario from Launch Pad 3.
- Development of a time-dependant puff model (duration up to 15.5 s) of a jet release using ADMS 6 in a range of meteorological conditions and wind directions in typical UK and Shetland-specific wind speeds.
- Development of a time-integrated dose model to predict total dose of CO at the closest residential receptor during the lifetime of the puff release (calculated at 1-minute intervals) using ADMS 6 in a range of meteorological conditions and wind directions.
- Conversion of total dose to 1-hour and 8-hour running mean concentrations for comparison with the relevant air quality standard (AQS) for CO for the protection of human health, (results presented in tables).
- Contour maps demonstrating the puff concentration at 1-minute intervals after the launch for the most frequent meteorological condition, using Unst average wind speeds; and
- Results.

Effects Scoped Out of the Assessment

7.4.2 There are no airborne pollutants associated with launches considered likely to have any significant adverse effects on ecological receptors. Therefore, the effect of emissions from launches on ecological sites has not been considered further in the assessment.

Environmental Zone of Influence

7.4.3 Maps and aerial images of the Proposed Project and the surrounding area have informed the selection of an appropriate air quality study area for the assessment.

7.4.4 The closest air quality sensitive receptors in each direction from Launch Pad 3 were identified, and a study area of 4 km was defined to track the concentration of the puff release from launch until concentrations returned to normal ambient background levels under a range of meteorological conditions. The closest occupied sensitive receptor is Banks Cottage at Norwick which is 2,440 m from Launch Pad 3. This is shown as R1 on Drawing 7.1 in Volume III.

7.4.5 The air quality study area is included within the environmental zone of influence (EZI) for the Proposed Project.

Method of Assessment

7.4.6 Due to the remote location of the Proposed Project, the low baseline traffic movements, and a lack of industrial activity in the surrounding area, it was agreed with Shetland Islands Council that no ambient baseline air quality monitoring was required to support the SaxaVord Spaceport planning application. Instead, background air quality concentrations from published Government data were used and have subsequently been used in the SaxaVord Spaceport AEE and are considered fit for purpose for this assessment.

7.4.7 CAA guidance document (CAA, 2023) states that assessment of emissions on local air quality is required for any airspace change less than 1,000 feet in altitude.

7.4.8 The emission rate of exhaust gases from an Orbex PRIME Launch Vehicle will vary with height during the launch. However, they have been modelled as short-term puff releases from ground level for the duration it takes the Orbex PRIME Launch Vehicle to reach an altitude of 1,000 ft. This is considered to represent the maximum potential impact of emissions for identified receptors.

Launch Emissions

7.4.9 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicle from Launch Pad 3 at SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland.

7.4.10 The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year. In terms of launch frequency, it is anticipated that there will be a maximum of two launches per month, in line with SaxaVord Spaceport's commitment to a no-launch window between mid-May and the end of June to protect breeding birds.

7.4.11 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure. The fuel for both stages is Liquid Petroleum Gas (LPG), and Liquid Oxygen (LOX) as the oxidiser.

7.4.12 The majority of emissions from burning this propellent are water vapour (H_2O) alongside much smaller quantities of carbon dioxide (CO_2) and CO. Emissions are via six identical nozzles directed vertically downwards towards a flame deflector, thus resulting in a horizontal jet release close to ground level.

7.4.13 Launch greenhouse gas emissions (including CO_2) are quantified in Chapter 4.

7.4.14 To determine the maximum potential effects of emission from a launch at a sensitive receptor, the assessment considers the effects of emissions from Launch Pad 3 on air quality at receptor R1, Banks Cottage, the closest emission-receptor relationship.

7.4.15 CAA guidance document (CAA, 2023) states that assessment of emissions on local air quality is required for any airspace change less than 1000 feet in altitude. It is therefore only necessary for the AQIA to consider emissions from the Orbex PRIME Launch Vehicles during the first stage as subsequent stages occur at significantly higher altitudes. It has been calculated that it will take 15.5 seconds for the Orbex PRIME Launch Vehicle to reach an altitude of 1000 ft.

7.4.16 The "Puff" model in ADMS 6 (Cambridge Environmental Research Consultants, 2024) enables releases of up to one-hour duration to be modelled and concentrations at chosen downwind distances to be predicted at different timesteps (time in seconds after the start of the emission). It is therefore possible to track the concentration at any point during the whole lifetime of that puff release, for any given meteorological condition, and calculate the total "dose" at each location i.e., the total concentration that a person would be exposed to if they stayed at the same location for the whole time the puff passed overhead. When considering the potential exposure for a human receptor during a launch, the total dose concentration is the most appropriate. The total dose is then converted to an 8-hour average concentration for comparison with the AQS as detailed in Table 7.1.

7.4.17 The assessment is provided in detail in Appendix 7.1.

Impact Descriptors for Launch Emissions

7.4.18 The change in pollutant concentrations with respect to future baseline concentrations has been described at identified sensitive receptors. The absolute magnitude of pollutant concentrations in the "future with Proposed Project" scenario is described, and this is used to consider the risk of the AQSs being exceeded.

7.4.19 The IAQM has published recommendations for describing the magnitude of impacts and determining the significance of such impacts at individual receptors (Moorcroft and Barrowcliffe et al, 2017). The impact descriptors are summarised in Table 7.3**.** A change of less than 0.5% of the Air Quality Assessment Level (AQAL) is described as negligible.

Table 7.3– Impact Magnitude Descriptors for Individual Receptors

Long Term Average Concentration at Receptor	% Change in concentration relative to Air Quality Assessment Level (AQAL)			
	1%	2-5%	6-10%	>10%
75% or less of AQAL	negligible	negligible	slight	moderate
76-94% of AQAL	negligible	slight	moderate	moderate
95-102% of AQAL	slight	moderate	moderate	substantial
103-109% of AQAL	moderate	moderate	substantial	substantial
110% or more of AQAL	moderate	substantial	substantial	substantial

Overall Assessment of Significance

7.4.20 The reported magnitude impact at each receptor has been considered for the Proposed Project in overall terms. In addition, the potential for the Proposed Project to contribute to or hinder the successful implementation of policies and strategies for the management of local air quality has been considered. The descriptors used to characterise the overall significance of effects at sensitive receptors are summarised in Table 7.4.

Table 7.4 - Descriptors used for the Overall Assessment of Significance at Sensitive Receptors

Effect Descriptor	Significance
Major	A significant effect that is likely to be a material consideration in its own right.
Moderate	A significant effect that may be a material consideration in combination with other significant effects but is unlikely to be a material consideration in its own right.
Minor	An effect that is not significant but that may be of local concern.
Negligible	An effect that is not significant change.

Requirements for Mitigation

7.4.21 Proposed mitigation measures are presented in Section 7.7.

Assessment of Residual Effect

7.4.22 An assessment of predicted significant residual effects, taking account of committed mitigation measures, is presented in Section 7.9.

7.5 Baseline Conditions

7.5.1 There are no local monitoring stations measuring background concentrations of CO in the Shetland Islands. The background concentration of CO for the study area was therefore downloaded from the Defra background concentration maps (DEFRA, 2025) for Shetland based on 1km x 1km grid square values. The maximum background concentration of 0.051 mg/m^3 from the grid squares covering a 25 km^2 study area around the Proposed Project (NGR 462500,1211500-NGR 467500, 1216500) was used as a representative value across the air quality study area.

7.6 Receptors Brought Forward for Assessment

7.6.1 The receptor brought forward for assessment is:

- Banks Cottage at Norwick as the closest residential receptor to Launch Pad 3 (shown on Drawing 7.1).

7.7 Standard Mitigation

Vehicle Emissions

7.7.1 Improvements to the existing public road network and the construction of the New Section of Access Road at Northdale required by the planning conditions for SaxaVord Spaceport will act to mitigate against congestion pinch points that could lead to an increase in vehicle emissions due to reduced speed and stop-start behaviour during operation of the Proposed Project.

7.7.2 SaxaVord Spaceport will use electric vehicles to collect and transport launch operator staff and visitors and as such this will mitigate emissions from the Proposed Project.

A Spectator Traffic Management Plan has been developed for SaxaVord Spaceport to avoid congestion and encourage sustainable transport choices.

7.7.3 Consideration of activities related to spectators/visitors to SaxaVord Spaceport and their associated potential impact on the environment falls under the remit of SaxaVord Spaceport, rather than individual launch operators.

7.7.4 SaxaVord Spaceport has the responsibility of managing spectators/visitors to launch events. All operations by the Applicant will be required to align with the SaxaVord Spaceport Spectator Traffic Management Plan.

7.8 Potential Effects

Launch Emissions

7.8.1 The assessment of the potential effects of emissions from launches in Appendix 7.1 predicted ambient CO concentrations at short term (1-minute) intervals after release.

7.8.2 The results show that during a launch event from Launch Pad 3, the concentration of CO at R1 was detectible above background levels for periods of up to 14 minutes considering a range of atmospheric stability conditions using Unst average wind speeds and an east north-east wind, after which time, concentrations reverted to background CO levels. Exposure times were lower wither other wind directions.

7.8.3 The maximum predicted dose of CO with Unst wind speeds at R1 was 429.25 mg.s/m^3 over four minutes. This is equivalent to a maximum dose over the lifetime of the jet release of 375 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of four minutes. A person would have to be exposed to this dose for two to three hours of constant exposure to experience headache or dizziness (Goldstein, 2008).

7.8.4 The maximum predicted 8-hour concentration at R1 was 0.068 mg/m^3, 0.68% of the AQS, when modelled using UK average convective (Stability E) meteorological conditions with wind from the east north-east (67.5°). This reduced to 0.66% of the AQS when average Unst wind speed conditions were modelled for this direction.

7.8.5 On analysis of the meteorological data, an east north-east (67.5°) wind only occurs for approximately 8% of the year on Unst. There is therefore a high probability that launch events will take place under the local prevailing wind conditions which, over the period 2020-2024, were southerly to westerly. Under prevailing conditions, there is no detectible impact of launch emissions at the closest receptor R1 in UK or Unst average wind speed conditions.

7.8.6 The assessment has demonstrated that there is no risk of exceedance of the 8-hour AQS for CO at any sensitive receptor in the vicinity of the Proposed Project irrespective of the prevailing weather conditions during a launch and there are no health effects associated with the maximum predicted short-term exposure over four minutes.

7.8.7 The effect of launch emissions on all identified receptors is concluded to be of negligible significance, therefore resulting in no likely significant effect.

7.9 Cumulative Assessment

7.9.1 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, it is considered that there are no potential inter-project cumulative effects as there are no other relevant existing or proposed developments in the EZI.

7.9.2 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent.

7.9.3 SaxaVord Spaceport has a proposed capacity for 30 launches per annum. The Proposed Project will account for 10 of those launches. As detailed in this chapter, emissions from propellants used to launch the Orbex PRIME Launch Vehicle are not anticipated to result in significant effects at identified receptors and are similar in scale to those predicted in the SaxaVord Spaceport AEE.

7.9.4 Given that there will be no more than one launch with any 24-hour period and launches will be phased with enough separation time for the EZI to return fully to its baseline state between launches, it is considered that there is no potential for additive launch event or intra-project cumulative effects.

7.10 Residual Effects

7.10.1 The residual effects on air quality from the Proposed Project are concluded to be of negligible significance, therefore resulting in no likely significant effect.

7.11 Summary

7.11.1 An assessment of the potential effects of emissions from the Proposed Project on local air quality has been undertaken.

7.11.2 Launch emissions are predicted to have no perceptible impact at any identified receptors under prevailing wind directions.

7.11.3 The maximum predicted impact at a sensitive receptor is predicted to occur with east north-easterly winds which occur typically for less than 10% of the year.

7.11.4 The maximum predicted dose of CO with Unst average wind speeds at R1 was 429.25 mg.s/m^3 over four minutes. This is equivalent to a maximum dose over the lifetime of the jet release of 375 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of four minutes. A person would have to be exposed to this dose for two to three hours of constant exposure to experience headache or dizziness (Goldstein, 2008).

7.11.5 The maximum predicted 8-hour concentration of CO at a sensitive receptor is 0.66% of the AQS.

7.11.6 Emissions from launch events are therefore considered to have a negligible impact on air quality, resulting in no likely significant effect.

7.12 References

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Chapter 8 Noise and Vibration

8. Noise and Vibration

8. Noise and Vibration

8.1 Introduction

8.1.1 This chapter considers the potential noise and vibration effects associated with the Proposed Project.

8.1.2 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicle from Launch Pad 3 at SaxaVord Spaceport Lamba Ness Launch Site (LNLS) situated at Lamba Ness, Unst, Shetland.

8.1.3 The Applicant is applying for a maximum environmental budget of 10 launches per year which, when maximum launch cadence is reached, will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year, and as such is applying to the UK Civil Aviation Authority (CAA) for a launch operator licence as required by the Space Industry Act 2018.

8.1.4 Whilst the Applicant has not yet determined a specific timeframe for launch operations, when required for the purposes of this AEE an operational phase of 30 years (equating to 300 launches) has been assumed, aligning with the current land lease for SaxaVord Spaceport.

8.1.5 For the purposes of the noise assessment, the effects of the Applicant's proposed launch budget, within the wider SaxaVord Spaceport budget of 30 launches a year in terms of cumulative effects, has been assessed so as to give the predicted effects over any one year.

8.1.6 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure and designed to launch payloads of up to 180 kg into both sub-orbital trajectories and sun synchronous and polar orbits. All launch trajectories will follow a northerly direction over the sea. All Orbex PRIME campaigns will launch solely from Launch Pad 3 at SaxaVord Spaceport.

8.1.7 The noise related characteristics (i.e., dimensions, mass and sea level thrust) of the Orbex PRIME Launch Vehicle are within the envelope of the representative launch vehicle (RepLV) previously assessed as part of the planning application for SaxaVord Spaceport (reference 2021/005/PPF) and the subsequent SaxaVord Spaceport operator licence application (reference SR-APP-001019). Noise modelling parameters for the SaxaVord Spaceport RepLV comprised a 29 m rocket with a 1.8 m diameter, mass of 10,049 kg and sea level thrust of 633,658 N.

8.1.8 The Orbex Prime Launch Vehicle sits comfortably within these dimensions and has a sea level thrust of approximately one third that of the SaxaVord RepLV. As such, noise impacts from the Proposed Project will be less than those predicted for the RepLV, since noise from rockets is primarily a factor of thrust, and a lower thrust is required to propel a smaller, lighter launch vehicle. This AEE therefore reports on the same noise modelling and assessment undertaken for the SaxaVord Spaceport AEE but frames the findings in the context of the Proposed Project.

Scope of Assessment

8.1.9 The scope of the noise impact assessment comprised the following:

- Baseline noise survey at the SaxaVord Spaceport site (2018);
- Evaluation of predicted road traffic noise for SaxaVord Spaceport operation;
- Modelling of engine testing and launch noise from 30 orbital launches per year from SaxaVord Spaceport (undertaken by BRRC);
- Evaluation and interpretation of modelling results; and,
- Specification of appropriate mitigation.

8.1.10 Ground-borne vibration effects associated with launches will be highly localised and are considered to be negligible at human receptor locations. The evaluation of ground-borne vibration effects has therefore been scoped out of this assessment.

8.1.11 Prediction of noise associated with launch vehicles, including static engine tests[1] and launches, has been undertaken by Blue Ridge Research and Consulting LLC (BRRC). BRRC is an acoustical engineering consultancy focused on critical noise and vibration challenges for aerospace, aviation, and US Department of Defense projects. With experience from more than 250 civilian and military noise studies, BRRC's team of acoustical engineers is recognised as a trusted advisor to public, private, and academic clients in the space industry around the world.

8.1.12 BRRC's modelling evaluates the potential impacts of launch vehicle noise and sonic booms on a cumulative basis in terms of human annoyance. In addition, potential impacts are evaluated on a single-event basis in relation to hearing conservation, sleep disturbance, speech interference, and structural damage. BRRC's modelling considers use of SaxaVord Spaceport, comprising all three launch pads and a total launch budget of 30 launches per year. The Orbex PRIME Launch Vehicle fits within the 'worst-case' envelope of potential launch vehicles considered in BRRC's predictions. As applicable, model results have then been incorporated into this AEE Report chapter by SLR Consulting.

8.1.13 The BRRC modelling assessment is provided in Volume IV Appendix 8.1. It is recommended that the reader reviews the BRRC report prior to proceeding with this chapter.

8.1.14 With reference to Volume IV Appendix 8.1 Figure 40, the sonic boom from launches will occur 60 km out to sea, away from populated areas. The AEE prepared for the Sutherland Spaceport projects that sonic booms would occur approximately 55 km from the launch site; this is similar to the 60 km considered in the SaxaVord AEE. Further consideration of air overpressure effects on structures and human receptors has been scoped out of this assessment.

Glossary of Acoustic Terms

8.1.15 Acoustics and vibration are necessarily highly technical disciplines, and as such there are numerous specific terms which are used within this assessment. The terms are defined here to aid the lay reader.

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[1] *The Applicant does not propose to undertake any static engine testing at SaxaVord Spaceport, therefore any predictions including static tests are considered highly conservative.*

- **Noise** – unwanted sound.
- **A-weighting** – an electronic filter applied to measured sound levels to approximate the hearing response of humans to different frequencies, denoted 'A' in noise indices.
- **Ambient level, $L_{eq,T}$** – the equivalent continuous sound pressure level (L_{eq}) of the totally encompassing sound in a given situation at a given time at the assessment location over a given time interval, T. Denoted $L_{Aeq,T}$ when A-weighted.
- **Background level, $L_{A90,T}$** - the A-weighted sound pressure level that is exceeded for 90 percent of a given time interval, T.
- **Maximum level, L_{Amax}** – the A-weighted maximum instantaneous sound level during a measurement period or noise 'event', recorded during a time interval, T.
- **Day-night noise level, L_{den}** - the A-weighted ambient level over a 24-hour period, with a +10 dB penalty for night-time noise (23:00 – 07:00) and a +5 dB penalty for evening noise (19:00 – 23:00). The L_{den} index is a cumulative yearly average, taking into account all noise 'events' associated with a particular source throughout the year.
- **Sound Exposure Level, SEL** – the SEL (alternatively the Single Event Noise Exposure Level, SENEL) is the one-second long steady level that contains as much sound energy as the varying level over the full event. The SEL is similar to the L_{eq}, however, the SEL uses a reference period of one second, whereas the L_{eq} can be expressed for any time interval.

8.2 Legislation, Policy and Guidelines

8.2.1 A short summary of relevant legislation, policy and guidelines that have been taken into consideration in this assessment is provided below. Where appropriate, detailed summaries of these documents for the lay reader are provided in Volume IV Appendix 8.2.

Legislation

Space Industry Act

8.2.2 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

8.2.3 As the Applicant wishes to become a spaceflight operator and launch the Orbex PRIME Launch Vehicle from the UK, they are required to apply for a launch operator licence, and as part of this application, submit an AEE of the Proposed Project.

Space Industry Regulations 2021

8.2.4 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Control of Noise at Work Regulations, 2005

8.2.5 The Control of Noise at Work Regulations (CoNaW Regs.) seek to protect against hearing damage by controlling the exposure of employees to noise during the course of their working day by providing threshold noise exposure values which trigger particular requirements of employers and employees.

8.2.6 The threshold noise exposure values relate to either daily or weekly personal exposure; the individual 'noise dose' received by an employee during work hours is calculated over the appropriate time period. Where an employee is exposed to noise levels above the thresholds, certain requirements on behalf of the employer and employee are triggered, such that their risk of noise-induced hearing damage is minimised.

8.2.7 The threshold values are as follows:

- Lower Exposure Action Value (LEAV);
  - Daily or weekly personal noise exposure of 80 dB(A) and,
  - Peak sound pressure of 135 dB(C);
- Upper Exposure Action Value (UEAV);
  - Daily or weekly personal noise exposure of 85 dB(A) and,
  - Peak sound pressure of 137 dB(C);
- Exposure Limit Value (ELV);
  - Daily or weekly personal noise exposure of 87 dB(A) and,
  - Peak sound pressure of 140 dB(C).

8.2.8 A weekly value may be used where the exposure of an employee varies markedly from day to day.

8.2.9 The daily exposure is calculated using the following formula:

$$L_{EP,d} = L_{Aeq,Te} + 10\log_{10} (T_e/T_0)$$

8.2.10 Where:

- T_e is the duration of the person's working day in seconds;
- T_0 is 28,800 seconds (8 hours); and,
- $L_{Aeq,T}$ is the equivalent continuous A-weighted sound pressure level that represents the sound the person is exposed to during the working day.

Policy

Planning Advice Note PAN1/2011

8.2.11 PAN1/2011 (Scottish Government, 2011), sets out a series of noise issues for planning authorities to consider when making decisions on planning applications. A Technical Advice Note (TAN) on Assessment of Noise (Scottish Government, 2011) has been published to accompany PAN 1/2011. The TAN sets out appropriate technical guidance for evaluating different sources of noise and provides an example framework for determining impact magnitude and effect significance.

Consultation Response on UK Airspace Policy: A Framework for balanced decisions on the design and use of airspace

8.2.12 In February 2017 the UK Government put forward proposals to address the noise impact of aviation as part of a consultation on how changes to airspace could be implemented to allow airports to keep up with demand.

8.2.13 The consultation response noted that the UK Government believes that the 54 $dBL_{Aeq,16hr}$ metric remains appropriate, on the basis of a Survey of Noise Attitudes Study (SoNA, 2014) commissioned by the Department for Transport (DfT) which indicated that the degree of annoyance based on percentage of respondents 'highly annoyed' previously occurring at 57 dBL_{Aeq},16hr now occurs at 54 $dBL_{Aeq,16hr}$.

Shetland Local Development Plan 2014

8.2.14 The Local Development Plan notes that:

- Development should not have a significant adverse effect on existing uses;
- Development should not compromise acceptable health and safety standards or levels; and
- Development should be consistent with National Planning Policy, other Local Development Plan policies and Supplementary Guidance.

Guidance

Guidance for the Assessment of Environmental Effects

8.2.15 The Guidance for the Assessment of Environmental Effects (AEE) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

8.2.16 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- The launch operator AEE must cover all operations and activities that could have an environmental effect from the proposed launch(es);
- The applicant must provide a detailed assessment of the environmental effects of the specific launch(es) they are intending to apply for. The regulator will expect more detailed data for a launch operator AEE than for a spaceport AEE as the launch vehicle(s) will be known. The AEE must be based on the actual details of the class, type and detailed requirements of the launch vehicle and must not be based on assumptions;

- If more than one launch is being applied for, under the same launch operator licence application, then a cumulative assessment of those launches must be conducted. The launch operator AEE must also include any test launch(es) that will be authorised by the launch operator licence;
- The AEE must cover the entire launch operation, including:
  - from ground processing to the injection of the payload on orbit;
  - reusable or/and refurbishable elements, for example, the return flight of a reusable spaceplane;
  - objects jettisoned during the course of a nominal launch operation, for example, spent stages and fairings; and
  - for a sub-orbital operation, until the vehicle returns to earth
- The AEE must address a range of environmental topics, including noise.

Guidance to the Regulator on Environmental Objectives Relating to the Exercise of its Functions Under the Space Industry Act 2018

8.2.17 The Department for Transport issued its document ‘Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018’ in 2021, clarifying the government’s environmental objectives relating to spaceflight and associated activities in the UK:

8.2.18 The environmental objectives for spaceflight are to:

- Minimise emissions contributing to climate change resulting from spaceflight activities
- Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities
- Protect people and wildlife from the impacts of noise from spaceflight activities
- Protect the marine environment from the impact of spaceflight activities.

8.2.19 The guidance identifies that noise from spaceflight activities is anticipated to be one of the greatest environmental concerns for impacts to humans and wildlife.

8.2.20 It is further noted that noise generated by spaceflight activities is not covered by WHO guidelines, ISO or BSI assessment methods, however, fixed spaceport activities should be assessed in accordance with BS 4142, as for any other type of industrial noise.

8.2.21 With regard to appropriate indices for the evaluation of rocket noise, the guidance notes the following:

‘When assessing distinct and infrequent noise, such as rocket noise, measures of single events such as the maximum noise level (LAmax) and the sound exposure level (SEL or LAE) are most appropriate. Unweighted maximum noise level (Lmax) may also be appropriate for assessing risk of structural damage to the surrounding buildings and properties. To avoid acute damage to the human inner ear resulting from impulsive sounds, WHO noise guidelines suggest the maximum sound level (LAmax) should never exceed 110 dBLASmax. To avoid and minimise the risk of structural damage the maximum unweighted noise level (LASmax) should not exceed 120 dB (unweighted).'

8.2.22 The guidance notes that the regulator must ensure:

- That where the rocket launch noise footprint could result in exposures in excess of 80, 85, 90, 95 and 100 dBL_{ASmax}, that these areas are published on suitable maps and used to communicate with local stakeholders.
- Where a night-time launch has been proposed by an applicant, the regulator should ensure that the applicant has assessed the risks to sleep disturbance in the vicinity around the launch using the following probability of awakening (equation provided in guidance).
- That any noise assessment provided takes into account an assessment of noise under predominant meteorological conditions and favourable weather conditions for launch where they differ.
- That any noise assessment provided clearly identifies the sources of noise and establishes what levels of noise have no observed effect, which have low observed adverse effects, and which have significant observed adverse effects.
- That a range of noise metrics have been assessed in addition to A-weighted measurements when considering a sonic boom. Where sonic booms over land cannot be avoided, the maximum overpressure should not exceed 47.88 pascals (Pa).
- All reasonable steps have been taken by operators to mitigate and minimise the adverse effects of noise events on human health and sensitive wildlife receptors.

8.2.23 The guidance notes that the noise assessment should include noise arising from ground operations and ancillary services, such as increased vehicle movement, generators and on-site equipment, assembly of launch vehicles, propellant loading and (if relevant) static fire testing.

8.2.24 Example mitigation measures are provided, including site selection away from sensitive receptors, applying operational procedures, e.g., restrictions during the night-time, seasonal restrictions, and implementing launch caps.

British Standard BS4142:2014+A1:2019

8.2.25 BS4142 describes methods for rating and assessing sound from industrial or commercial premises at residential receptors by comparison of the rating level due to the noise source with the background level in the absence of noise from the source.

- The following evaluation impact significance identifiers are provided in the Standard, in which the difference between the rating level and measured background level are considered:
- The greater the difference, the greater the magnitude of impact;
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact;
- A difference of around +5 dB is likely to be an indication of an adverse impact;
- The lower the rating level, relative to the measured background level, the less likely that the specific sound source will have an adverse (or significant adverse) impact; and,

- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

Calculation of Road Traffic Noise (CRTN)

8.2.26 CRTN (Department of Transport, 1988) provides a method for the prediction of noise levels due to road traffic based on traffic flows, average speed, road type and geometry.

Converting the UK traffic noise index LA10,18hr to EU noise indices for noise mapping

8.2.27 This report by TRL Ltd. may be used to convert CRTN 10th percentile ($L_{A10,18hr}$) noise index values to equivalent continuous ($L_{Aeq,T}$) index values, including $L_{Aeq,16hr}$, L_{day} and L_{night}.

Design Manual for Roads and Bridges (DMRB)

8.2.28 DMRB provides standards and advice regarding the assessment, design and operation of roads in the UK and provides significance criteria by which the percentage of people adversely affected by traffic noise can be related to the total noise level due to road traffic, or the increase over existing levels.

ISO 9613: Attenuation of sound during propagation outdoors, Part 1 and Part 2

8.2.29 ISO 9613 provides a calculation method for determining the attenuation of sound during propagation outdoors to predict the levels of environmental noise from a variety of sources.

The Environmental Noise (Scotland) Regulations 2006

8.2.30 The Regulations enact European Union Directive 2002/49/EC relating to the assessment and management of environmental noise in Scotland. The Regulations require that noise strategic noise maps are made showing the contribution of road, rail, aircraft and industrial activities. The strategic maps are to be used to develop noise action plans for areas close to major airports and other infrastructure. The Regulations use the noise indices L_{den} and L_{night}.

World Health Organization – Environmental Noise Guidelines for the European Region (WHO ENG)

8.2.31 The World Health Organization (WHO) was requested by the Member States in the European Region to produce noise guidelines that included not only transportation noise sources but also personal electronic devices, toys and wind turbines, which had not yet been considered in existing guidelines. Furthermore, European Union Directive 2002/49/EC relating to the assessment and management of environmental noise (END) and related technical guidance from the European Environment Agency both elaborated on the issue of environmental noise and the importance of up-to-date noise guidelines.

8.2.32 The WHO Regional Office for Europe has therefore developed environmental noise guidelines for the European Region, proposing an updated set of public health recommendations on exposure to environmental noise.

8.2.33 A strong recommendation can be adopted as policy in most situations. The guideline is based on the confidence that the desirable effects of adherence to the recommendation outweigh the undesirable consequences. The quality of evidence for a net benefit – combined with information about the values, preferences and resources – inform this recommendation, which should be implemented in most circumstances.

8.2.34 With regard to aircraft noise, the Guidelines provide the following recommendations:

'For average noise exposure, the Guideline Development Group (GDG) strongly recommends reducing noise levels produced by aircraft below 45 dB Lden, as aircraft noise above this level is associated with adverse health effects. For night noise exposure, the GDG strongly recommends reducing noise levels produced by aircraft during night-time below 40 dB Lnight, as night-time aircraft noise above this level is associated with adverse effects on sleep.

To reduce health effects, the GDG strongly recommends that policy-makers implement suitable measures to reduce noise exposure from aircraft in the population exposed to levels above the guideline values for average and night noise exposure. For specific interventions the GDG recommends implementing suitable changes in infrastructure.'

8.2.35 The WHO ENG relies on meta-analysis of studies of the effects of aircraft noise on populations and determined that there was an absolute risk of 10% of a population would be 'highly annoyed' at an aircraft noise exposure level of 45.4 dB L_{den}. The quality of the supporting evidence was reported to be 'moderate'.

8.2.36 The International Civil Aviation Organization (ICAO) 2019 Environmental Report (ICAO. 2019) considers whether aircraft noise annoyance has increased over the last 50 years considered the case presented in the WHO ENG, given that the 45 dB L_{den} recommendation is 10 dB (i.e., an order of magnitude) below the previous recommendation of 55 dB L_{den}. The study concluded that there has been no change in people's response to aircraft noise over the past 50 years, however, there is a substantial spread in the annoyance response, which is attributed to non-acoustic factors, with examples such as noise sensitivity, fear of accidents, mistrust towards airport authorities, maximum noise levels, changes in exposure patterns and the duration of silent periods between noise events listed. On the basis of the ICAO report, this assessment considers the WHO ENG 45 dB L_{den} recommendation to be a highly conservative method for determining potential community annoyance.

World Health Organization –Guidelines for Community Noise (GCN)

8.2.37 The GCN notes the following with regard to sleep disturbance:

8.2.38 If the noise is not continuous, L_{Amax} or SEL are used to indicate the probability of noise induced awakenings. Effects have been observed at individual LAmax exposures of 45 dB or less. Consequently, it is important to limit the number of noise events with a L_{Amax} exceeding 45 dB.

Aircraft noise effect on sleep: application of the results of a large polysomnographic field

8.2.39 With regard to potential sleep disturbance, Basner et al. (2006) noted that a healthy adult briefly awakens around 20 times during an 8-hour night period in environments without external stressors, and there should be less than one additional awakening induced by aircraft noise per night for the avoidance of adverse health effects.

8.3 Consultation

8.3.1 Extensive statutory consultation on noise matters was carried out during preparation and determination of the planning application for SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period and subsequent consultation with the CAA pertaining to this application has been summarised in Table 8.1.

Table 8-1 SaxaVord Spaceport Consultation Responses directly relevant to this AEE

Consultee	Consultation sent/response	Action taken
Shetland Islands Council	Email sent 11th July 2018 seeking agreement of representative study area and noise sensitive receptors, representative baseline survey locations (based on SaxaVord Spaceport project footprint at the time).	Shetland Islands Council confirmed they could not respond prior to survey being undertaken. Robust survey undertaken with reference to appropriate UK guidance.
Shetland Islands Council and SEPA	Email sent 9th June 2020 Outlining ITPEnergised's role in the noise and vibration assessment and seeking agreement on method of evaluation of construction, operational non-launch and launch noise for the SaxaVord Spaceport planning application EIA Report.	-
SEPA	15th June 2020 SEPA email received confirming it is unlikely that a licence under the Pollution Prevention and Control (PPC) regulations was required, therefore the Proposed Project is not within SEPA's remit	No action required
Shetland Islands Council	26th June 2020 email received confirming proposed approach and suggested threshold values are appropriate.	No action required
Civil Aviation Authority (CAA)	ITPEnergised provided interpretation of the CAA guidance and described our proposed approach to the assessment. The CAA responded to confirm that it was unable to comment until an application was formally submitted, however, the interpretation of the guidance should be "*proportional and appropriate to the operation*."	Context regarding interpretation of the guidance is included within this report

8.4 Assessment Methodology and Significance Criteria

Consultation

8.4.1 Details of communications with regulatory bodies are provided in Section 8.3. Consultation was undertaken prior to the baseline survey in 2018 and at the time of the detailed assessment for the SaxaVord Spaceport planning application in 2020.

Environmental Zone of Influence

For a new development, a noise impact study area is chosen based on the number of receptors at which the development may be audible or has the potential to exceed a particular noise threshold. A sample of the closest or most-affected noise sensitive receptors (NSRs) would then be selected for the detailed evaluation of impacts, with impacts at more distant receptors considered to be lesser.

8.4.2 Determining an acceptable level of impact at the closest NSRs is assumed to entail an acceptable level of impact at all receptors within the wider noise impact study area.

8.4.3 The Proposed Project comprises the preparation and launch of the Orbex PRIME Launch Vehicle from Launch Pad 3 at SaxaVord Spaceport situated at Lamba Ness in Unst, Shetland. The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of the SaxaVord Spaceport environmental budget of 30 launches per year.

8.4.4 Ancillary operations within scope of the Proposed Project include transport of personnel and equipment (including the Orbex PRIME Launch Vehicle), assembly and fuelling.

8.4.5 The noise impact study area for this assessment has been informed by maps and aerial images of the Proposed Project areas and its surroundings, as well as site visits undertaken during the baseline noise survey. A buffer of five kilometres (km) from the boundary of the Proposed Project has been chosen for the consideration of noise effects. Noise effects may occur beyond this buffer; however, potential effects will be most significant within.

8.4.6 SaxaVord Spaceport lies at the northernmost tip of the UK and launches will all have a northerly bearing. As such, there will be no permanent human Noise Sensitive Receptors (NSRs) along the trajectory of the Orbex PRIME Launch Vehicles, and a circular noise impact study area is sufficient to consider the worst-case noise impacts. There will be no on-land ecological receptors north of launch site and noise impacts will diminish rapidly as the launch vehicle gains altitude, such that consideration of worst-case noise impacts to ecological receptors can be achieved within the five km circular noise impact study area buffer.

8.4.7 The noise impact study area is included within the wider environmental zone of influence (EZI) for the Proposed Project.

8.4.8 A sample of the closest, and therefore potentially worst-affected, Noise Sensitive Receptors (NSRs) to the Proposed Project have been identified and adopted for the evaluation of noise impacts. These are listed in Section 8.6. While vibration impacts have been scoped out of this assessment on the basis that vibration effects will be negligible, we note that the NSRs identified will also be the closest Vibration Sensitive Receptors (VSRs).

8.4.9 NSRs are typically considered to include residential buildings, such as private dwellings, as well as institutional and cultural buildings, such as schools, hospitals, churches and museums. Of these types of potential NSR, only residential buildings have been identified within the adopted EZI.

Site Visit and Baseline Noise Survey

8.4.10 The baseline noise survey in the vicinity of the Proposed Project was originally conducted by ITPEnergised on 19 and 20 July 2018. Approximately seven years have elapsed since the baseline data was collected, however, given the rural and remote nature of the site setting, this assessment considers that no significant changes will have occurred to the baseline noise environment since the survey was completed. Monitoring was undertaken in accordance with the methods outlined in BS7445 and BS4142.

8.4.11 Measurements were undertaken using a Rion NL-52 Class I sound level meter (SLM). The SLM and calibrator were within their laboratory calibration period, and field calibration checks were performed before and after every measurement. No significant drifts in calibration were noted. A 5-minute averaging period was used for measurements, and the SLM was set to A-weighting and fast averaging. A hand-held anemometer was used to determine the wind speed at each monitoring position.

8.4.12 A single measurement of approximately 30 hours was undertaken at SaxaVord, and supplementary spot measurements of shorter durations were undertaken at locations representative of residential properties close to proposed infrastructure associated with the Proposed Project, both during the daytime period (07:00 - 23:00) and the night-time period (23:00 – 07:00), as defined in PAN1/2011 TAN. The noise monitoring positions (NMPs) used are shown in Drawing 8.1.

8.4.13 Measurements were undertaken in accordance with the requirements of BS4142, with low wind speeds (<5 m/s) and no rain. Records of the baseline survey are provided in Volume IV Appendix 8.3.

Assessment of Potential Effect Significance

Overall Approach to Launch Operator AEE, Reliance on Previous Studies

8.4.14 ITPEnergised originally undertook the AEE for the SaxaVord Spaceport Operator Licence application. The SaxaVord Spaceport AEE noise assessment considered a similar (though larger and more powerful) launch vehicle to the Orbex PRIME, the 'SaxaVord Spaceport RepLV', which then considered a 'worst-case' launch schedule of 30 launches.

8.4.15 Specific road traffic movement numbers associated with the Applicant's launches fall within the envelope considered for the SaxaVord Spaceport AEE.

8.4.16 As such this AEE reports on the same noise modelling and assessment undertaken for the SaxaVord Spaceport AEE but frames the findings in the context of the Proposed Project in isolation.

Receptor Sensitivity

8.4.17 The guidance contained within the Technical Advice Note to PAN 1/2011 has been drawn upon in the generation of an appropriate set of significance criteria. The receptor sensitivity criteria are presented within Table 8.2.

Table 8-2 NSR and VSR sensitivity criteria

Receptor Sensitivity	Description	Examples
High	Receptors where people or operations are particularly susceptible to noise and/or vibration.	Residential, quiet outdoor recreational areas, schools and hospitals.
Medium	Receptors moderately sensitive to noise and/or vibration, where it may cause some distraction or disturbance.	Offices and restaurants.
Low	Receptors where distraction or disturbance from noise and/or vibration is minimal.	Buildings not occupied, factories and working environments with existing levels of noise.

Impact Magnitude Criteria

8.4.18 Threshold noise levels have been defined for the Proposed Project. The derivation of threshold levels is described in subsequent sections, however, the general approach to deriving the magnitude of noise impacts for different aspects of the project is provided below.

Road traffic

8.4.19 A previous version to the current iteration of DMRB provided the following general relationship between changes in traffic flow and the resultant change in the traffic noise: "*In the period following a change in traffic flow, people may find benefits or disadvantages when the noise changes are as small as 1 dB(A) – equivalent to an increase in traffic flow of 25% or a decrease in flow of 20%. These effects last for a number of years*". By contrast, PAN1/2011 advises that a change of 3 dB(A) is the minimum perceptible change in noise outside of laboratory conditions.

8.4.20 CRTN provides a procedure for calculating road traffic noise for links with low flows, defined as between 50 and 200 vehicle movements per hour, or 1,000 to 4,000 vehicle movements per day, and notes that calculations of noise level for traffic flows below these ranges are unreliable, recommending that measurements be undertaken when evaluating such cases.

8.4.21 Using these principles, the noise impact magnitude has been determined according to the criteria provided in Table 8.3.

Table 8-3 Road traffic noise impact magnitude criteria

Increase (i) over existing road traffic noise level due to project-generated traffic flows, dB	Impact magnitude
$i \geq +5$	High
$+3 \leq i < +5$	Medium

Increase (i) over existing road traffic noise level due to project-generated traffic flows, dB	Impact magnitude
$+1 \leq i < +3$	Low
$0 \leq i < +1$	Negligible

Noise from engine testing and launches

8.4.22 No standard UK or Scottish guidance exists upon which the magnitude of noise impacts associated with launches is available. This assessment has therefore considered as a robust basis of assessment, the potential for adverse health effects on the local population by reference to guidelines for aircraft noise provided by the WHO and the EU with regard to potential annoyance, and to the CoNaW Regs with regard to the potential for hearing damage.

8.4.23 Guidance relating to aircraft noise is a useful point of reference with regard to potential annoyance and sleep disturbance, however, it is noted that the character, duration and level of noise associated with launch vehicle launches will differ from that associated with conventional civilian or military airfields.

8.4.24 Given the nature of noise from launches, with high levels of noise occurring over a relatively short duration, two metrics have been considered for the determination of noise impact magnitude as follows:

- Firstly, the L_{den} noise level has been used to determine the potential for community annoyance; and,
- Secondly, instantaneous L_{Amax} noise levels have been considered with regard to potential adverse health/discomfort impacts.

8.4.25 This two-tier approach seeks to set in context the L_{den} levels generated by short-duration noisy events averaged over a year.

8.4.26 With reference to para. 8.4.14 this AEE relies on L_{den} calculations undertaken in support of the SaxaVord Spaceport AEE which consider the cumulative effect of thirty launches of a launch vehicle similar to the Orbex PRIME Launch Vehicle per annum across three launch pads, including daytime, evening and night-time launches. The L_{den} is a cumulative metric considering annual exposure, including weightings for evening and night-time events. While the Proposed Project will account for approximately one third of the total number of launches and their respective impacts, the impact of these ten launches cannot be meaningfully considered in isolation. This assessment of noise effects therefore considers noise impacts from the Proposed Project in combination with those of other launch operators who will use SaxaVord Spaceport for the L_{den} index.

8.4.27 The threshold criteria for the L_{Amax} index adopt the CoNaW Regs thresholds, and robustly assume that the highest predicted $L_{Amax,1sec}$ level occurs at each NSR for the full duration of the noise 'event'. By way of context, sustained noise levels above 110 dB may cause discomfort and levels of 120 dB and above are considered the threshold of pain, therefore the CoNaW Regs thresholds are substantially below noise levels which may cause instantaneous discomfort to nearby residents. The impact magnitude criteria are presented in Table 8.4.

Table 8-4 Operational noise impact magnitude criteria matrix – launches – likelihood of annoyance (L_{den}) and noise exposure ($L_{EP,d}$)

Likelihood of annoyance threshold, dB L_{den}	Noise exposure, $dBL_{EP,d}$	Rationale	Impact magnitude
>45	≥85	Above threshold of community annoyance and above UEAV	High
	≥80, <85	Above threshold of community annoyance and below UEAV	Medium
	<80	Above threshold of community annoyance and below LEAV	Low
<45	<80	Below threshold of community annoyance and below LEAV	Negligible

8.4.28 At all NSRs where the predicted L_{den} is below the threshold for community annoyance and the $L_{EP,d}$ derived from predicted $L_{Amax,1sec}$ values is below the daily LEAV, the impact magnitude will be 'negligible'.

8.4.29 At all NSRs where the 45 dB_{Lden} threshold for community annoyance is exceeded, the impact magnitude will be greater than 'negligible', and the impact magnitude will be determined by the LEP,d relative to the CoNaW threshold values.

8.4.30 Further consideration has been given to the number of additional potential awakening events, with regard to the findings of the aircraft noise effect on sleep study (Basner, 2006), with potential for night-time sleep disturbance determined by SEL values above 90 dB (BRRC) and L_{Amax} values above 45 dB. The number of awakenings expected for launch events has been quantified using the equation referenced in the Guidance to the Regulator.

Noise from non-launch activities and plant

8.4.31 For noise from fixed plant and non-launch activities such as assembly, maintenance and control buildings and activities, significance criteria have been derived based on the guidance contained within BS4142, i.e., by consideration of the difference between the rating level from the plant noise and the prevailing background sound levels, but also with respect to context and the resulting sound levels in absolute terms.

8.4.32 The impact magnitude scale for noise associated with fixed plant and non-launch activities has been derived based on the PAN1/2011 and BS4142 guidance and is presented in Table 8.5.

Table 8-5 Non-launch plant and activity noise impact magnitude criteria

Difference (d) between predicted operational noise level and applicable noise limit, dB	Impact magnitude
d ≥+5	High
0 ≤ d < +5	Medium
-10 ≤ d < 0	Low
<-10	Negligible

Vibration from engine tests and launches

8.4.33 Airborne vibration (air overpressure) associated with launches is considered with reference to predicted noise levels in the BRRC report, which notes that "*one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB (unweighted), and one in 1,000 households at 111 dB (unweighted)"*. These levels match the criterion in the CAA guidance whereby "*…the maximum unweighted noise level (L_{ASmax})*[2] *should not exceed 120 dB (unweighted*)". Vibration criteria are provided for the determination of effect significance in Table 8.6.

Table 8-6 Operational vibration (air overpressure) impact magnitude criteria matrix –launches – likelihood of structural damage

Likelihood of structural damage threshold, dBL_{max}	Rationale	Impact magnitude
≥120	Likelihood of damage complaints greater than 1 in 100 households	Medium / High
≤111, <120	Likelihood of damage complaints lesser than 1 in 100 households, greater than 1 in 1,000 households	Low
<111	Likelihood of damage complaints lesser than 1 in 1,000 households	Negligible

Effect significance

8.4.34 This assessment determines the significance of effects drawing on the example criteria provided in PAN1/2011 (refer to Table 1 in Appendix 8.2). The adopted criteria are provided for a range of NSR sensitivities in Table 8.7.

[2] *We note that the CAA guidance refers to "L_{ASmax}" values, however, we assume that the L_{max} (i.e. unweighted) value is intended here.*

Table 8-7 Effect significance criteria

Impact Magnitude	Effect significance		
	Low	Medium	High
High	Slight / Moderate	Moderate / Large	Large
Medium	Slight	Slight / Moderate	Moderate
Low	Neutral / Slight	Slight	Slight
Negligible	Neutral	Neutral	Neutral

8.4.35 This assessment considers effects with a significance of 'moderate' and above are significant and effects with a significance of 'slight' or below are considered not significant.

8.4.36 All noise sensitive receptors (NSRs) considered in this assessment are considered to have a high sensitivity to noise and vibration.

Limitations to Assessment

8.4.37 This assessment relies on information provided by BRRC. Launch data has been provided by the applicant to BRRC, who undertook verification and predictions of launches using proprietary methods as described in their report, Noise Study for Launch Vehicle Operations at Shetland Space Centre included in Volume IV as Appendix 8.1.

8.4.38 This assessment considers the methods and models developed by BRRC to be appropriate and notes their routine use in the United States of America to evaluate noise from similar launch facilities, including for NASA and SpaceX. Further details of BRRC's capability and experience are given in the document *BRRC Shetland Space Centre Data Call* included for reference in Volume IV as Appendix 1.1.

8.5 Baseline Conditions

8.5.1 During the baseline survey the noise environment was determined to be consistent between all monitoring locations. There was little anthropogenic noise, and natural sources such as bird calls, wind and wind-induced rustling of vegetation were the primary contributors to overall noise levels. Very infrequent vehicle movements were a lesser contributor, with traffic typically slow-moving and fewer than five movements per hour. A summary of the measured noise levels is provided in Table 8.8. Full details of the survey are provided in Volume IV Appendix 8.3.

Table 8-8 Summary of measured baseline noise levels

Monitoring position / period	Monitoring duration, T	Measured level, dB(A)			
		Ambient, $L_{Aeq,T}$	Background, $L_{A90,T}$	Maximum, $L_{Amax,T}$	10th percentile, $L_{A10,T}$
NMP1 (day)	1 hr	38	27	57	39
NMP1 (night)	35 min	38	19	53	32
NMP2 (day)	1.5 hr	40	33	53	42
NMP2 (night)	40 min	27	18	45	25

Monitoring position / period	Monitoring duration, T	Measured level, dB(A)			
		Ambient, $L_{Aeq,T}$	Background, $L_{A90,T}$	Maximum, $L_{Amax,T}$	10th percentile, $L_{A10,T}$
NMP3	30 hrs	45	22	51	34
NMP3 (day)	5 hrs	42	21	55	36
NMP4 (day)	15 min	41	31	61	39
NMP5 (day)	1.5 hr	39	28	57	39

8.5.2 With reference to the measured levels presented in Table 8.8, time-event plots provided for each NMP in Volume IV Appendix 8.3 and field notes, the following observations may be drawn regarding the baseline noise environment:

- Noise levels across the EZI are very low, representative of a remote, rural area with little or no influence from anthropogenic noise sources such as road traffic, air traffic, industry or power generation.
- The primary contributors to the noise environment are natural sources, such as bird calls and the wind, and agricultural sources, such as livestock.
- There is very little temporal variation in noise levels between the daytime and the night-time periods. This is particularly evident in the background (L_{A90}) trace for the 30-hour measurement at Saxa Vord, which ranges from <20 dB up to a maximum of 34 dB at 05:00, attributed to dawn chorus.
- There is very little spatial variation in noise levels between monitoring positions, with the main control on noise levels being the level of wildlife activity and atmospheric conditions.
- Throughout the daytime and the night-time period noise levels lower than the 'noise floor' of the SLM (the threshold below which accurate measurements cannot be obtained due to electrical 'noise' within the circuitry) were recorded at most of the NMPs.

8.5.3 Note that the higher noise levels recorded at NMP4 preceded a squall which required the measurement to be abandoned, therefore this measurement is not considered suitably representative of the noise environment and is provided for information only.

8.6 Receptors Brought Forward for Assessment

8.6.1 NSRs considered in this assessment comprise a representative sample of the closest inhabited dwellings to the Proposed Project falling within the EZI extending 5 km from SaxaVord Spaceport. The NSRs are shown in Drawing 8.1 and listed in Table 8.9.

Table 8-9 NSRs considered in assessment

NSR ID	NSR Name	Rationale for selection
NSR1	Booths	Representative of closest dwellings to the Proposed Project
NSR2	Valie	Representative of dwellings to the north-west of Norwick
NSR3	Norwick	Representative of dwellings within Norwick

NSR ID	NSR Name	Rationale for selection
NSR4	Millfield	Representative of slightly elevated dwellings to the east of Norwick
NSR5	Virse	Representative of dwellings to the south of Norwick
NSR6	Northdale	Representative of dwellings in Northdale
NSR7	Haroldswick	Representative of dwellings in Haroldswick

8.7 Standard Mitigation

8.7.1 The design and operation of the Proposed Project will incorporate the following standard mitigation:

- Assembly of the Orbex PRIME Launch Vehicles and integration of payload to be undertaken at appropriate facilities within SaxaVord Spaceport and measures will be in place to minimise generation of unnecessary noise.

8.7.2 No mitigation is possible to reduce instantaneous noise levels associated with launches; however, the following community engagement protocols will be followed to seek to minimise the potential for annoyance:

- The timing of the applicant's launches will be advertised by SaxaVord Spaceport well in advance, in local media and online, such that local residents can avoid launch noise if they choose. Predicted noise levels inside the closest dwellings will be substantially below the level at which discomfort or hearing damage would occur and residents wanting to minimise their noise exposure may choose to remain indoors when a launch is scheduled;
- SaxaVord Spaceport is engaging with the local community to support local jobs and increase employment, increase tourism to the area and connect with local schools and colleges to aid teaching of science and technology subjects. Such measures are expected to make the local community feel engaged with the Proposed Project and reduce the likelihood of non-acoustic factors contributing to annoyance associated with noise from launches (refer to para. 8.2.36). The applicant will support these community engagement initiatives.
- Suggestions for appropriate community liaison activities to which the applicant may contribute to are provided below:
  - Establish Liaison Group Forum;
  - Produce project update newsletter;
  - Media, website update, social media;
  - Briefings with site neighbours, landowners, community representatives, interest groups and other key stakeholders;
  - Produce leaflet detailing upcoming activities;
  - Send letters to stakeholders likely to be immediately affected;
  - Hold public open days / exhibitions;
  - Manage community helpline and general email contact;
  - Attend community council meetings quarterly; and,
  - Manage complaints procedure.

8.8 Potential Effects

Noise from launches

8.8.1 As noted above, this assessment relies on predicted noise levels associated with launches provided by BRRC. Full details of the modelling undertaken are provided in Volume IV Appendix 8.1, which should be read in conjunction with this AEE chapter.

8.8.2 The BRRC report notes that the predicted noise levels consider the most likely scenario with regard to meteorological conditions, rather than those specifically likely to be favourable for launches or favourable to propagation.

8.8.3 The predicted L_{den} values from all launch-related activities at SaxaVord Spaceport, including launches from all three launch pads and static engine tests, of which the Proposed Project comprises up to ten launches per year from Launch Pad 3, are provided in Table 8.10. Orbex does not propose to undertake any static engine testing at SaxaVord, therefore the reported L_{den} values may be considered to be conservative. The predicted L_{den} values are shown as contours at 5 dB intervals in Drawing 8.2. Where NSRs lie between contours an interval of values has been reported.

Table 8-10 Predicted L_{den} values at NSRs

NSR ID	Predicted level, dBL_{den}
NSR1	<60, >55
NSR2	<60, >55
NSR3	<60, >55
NSR4	<60, >55
NSR5	<60, >55
NSR6	<55, >50
NSR7	<50, >45

8.8.4 To provide context to the lay reader; a normal conversation may register a typical noise level of 60 dB, while ambient noise levels within a quiet office may range from 40 – 50 dB.

8.8.5 Predicted L_{den} values at all of the representative NSRs considered are greater than 45 dB, therefore the impact magnitude exceeds ‘negligible’ at all NSRs. As discussed above, this assumes that noise from a spaceport will generate similar levels of annoyance to noise from airports. This assessment considers that the very short duration and infrequent occurrence of noise from launches is likely to generate lower levels of annoyance than aircraft noise, which is far more frequent and regular and varies little from day to day. Launches will offer substantially greater periods of respite for nearby residents than an equivalent airport, and residents will be given warning in advance of each launch, such that they can plan accordingly to avoid the noise if they choose.

8.8.6 The predicted $L_{Amax,1sec}$ values for launches are provided in Drawing 8.3.

8.8.7 The predicted duration for which specific noise levels will be exceeded at NSR1 (the closest receptor to the Proposed Project) are provided in Table 8-11.

Table 8-11 Time above durations at 2 km

Level / rationale for use of level	Launch – time above level (seconds)
22 dB – representative 24-hour background level in Norwick.	340
45 dB – representative 24-hour ambient level in Norwick and also the external level which corresponds to the internal level of 30 dB via open-window transmission, above which sleep disturbance may occur.	190
66 dB – level above which speech intelligibility reduces; used to evaluate potential adverse effects of rocket noise within national parks in the USA.	70
89 dB – representative of maximum level during overflight by an oil rig shuttle helicopter, as occurs occasionally within the EZI.	45

8.8.8 The predicted durations provided in Table 8-11 consider use of all three launch pads of the spaceport. The Proposed Project will operate from Pad 3 only, the most distant of the launch pads from NSRs. The greater separation distance between the launch location and the NSRs will result in marginally lower noise levels and therefore shorter durations for the time above. The durations provided in Table 8.11 may therefore be considered to be worst-case.

8.8.9 A time-history chart, showing how the predicted noise level changes at the closest NSR throughout a launch is provided in Figure 8.1.

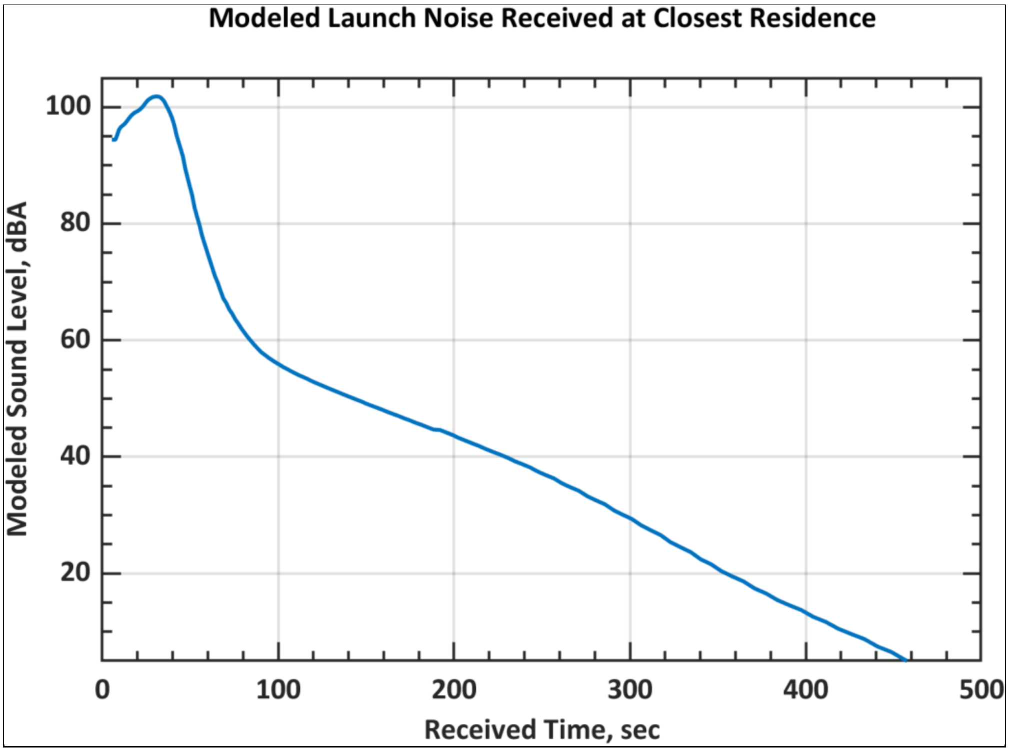

Figure 8.1 Time-history chart of launch noise

8.8.10 The noise levels at the closest NSR show a short-duration (approx. 50 seconds) peak where noise levels are in the range 80 – 100 dB(A), followed by a rapid decline to approx. 55 dB by 100 seconds. Figure 8.1 shows that the noise level drops to 45 dB, representative of the baseline ambient level, within 200 seconds. Table 8.11 above shows that the noise level drops below 22 dB, representative of the baseline background level and below which noise from the launch will trend towards being inaudible, within 340 seconds. The maximum duration of launches in terms of noise will therefore be approximately 340 seconds, or just under six minutes.

8.8.11 The BRRC report (Volume IV Appendix 8.1) considers an upper limit level of 115 dBL_{Amax} to protect human hearing from noise-induced hearing loss (NIHL), and notes that there are no dwellings within the 115 dB noise contour for operational noise associated with launches or engine tests.

8.8.12 Drawing 8.3 shows the predicted L_{Amax} contours for ten launches from Launch Pad 3, the highest predicted level occurs at NSR1 during with a predicted level of below 100 dBL_{Amax}. With reference to Table 8-11 and Figure 8.1, the predicted noise level at NSR1 is below 60 dB after approximately 80 seconds.

8.8.13 In a highly conservative assumption, the $L_{EP,d}$ has been calculated assuming that a 100 dB noise level occurs throughout the 80 second period. Using the equation provided in para. 8.2.9, the resultant $L_{EP,d}$ is 74 dB. This is substantially below the LEAV and the impact magnitude at this worst affected NSR is therefore low.

8.8.14 With reference to Table 8-7, the resultant effect significance for high sensitivity receptors is slight. Noise effects associated with launches are therefore not significant, resulting in no likely significant effect.

8.8.15 When considering potential increased sensitivity to noise during the night-time period, it is noted that the BRRC report states SEL values greater than 90 dB generally lead to sleep disturbance. Further, given a predicted 98 dBL_{Amax} level at NSR1, and assuming a reduction of approximately 30 dB to external levels provided by the building envelope, it is highly likely that launches during the night-time period would result in internal noise levels above 45 dBL_{Amax} with resultant potential awakening of sleeping population at all NSRs within the EZI, as per GCN guidance.

8.8.16 The Applicant's environmental budget is for a maximum of ten launches per year. In terms of launch frequency, it is anticipated that there will be no more than two launches per month and launches at all carried out between mid-May to end of June each year. As detailed in Appendix 8.1, it has been assumed for the purposes of noise monitoring that of the ten launches from each launch pad, two will be night-time launches. This assessment notes, however, that any number of night launches would still only result in a single launch during any given night, and therefore only one sleep disturbance per night.

8.8.17 Using the probability of awakening function given in the Guidance to the regulator on environmental objective relating to the exercise of its functions under the Space Industry Act 2018 and population data gathered by SaxaVord Spaceport and predicted noise levels associated with the RepLV, the number of awakenings expected are provided in Table 8-12.

Table 8-12 Expected additional awakenings from night-time launches of the RepLV

Location (noise contour band)	Input value, dBL_{Amax}	$P_{awakening}$	Population	Number of awakenings
100-95	100	0.17	40	6
95-90	95	0.16	94	15
90-85	90	0.15	40	6
85-80	85	0.15	130	19
Total	-	-	304	46

8.8.18 For any one night launch it is expected that 46 people out of a total 304 will be awoken.

8.8.19 Given the proposed frequency of launches and the short duration of the noise events associated with launches, with reference to the 2006 Basner study wherein restricting additional awakenings due to aircraft noise to a maximum of one event per night is anticipated to have no adverse effect on human health, adverse effects associated with sleep disturbance due to night-time launches are considered to be minimal.

Noise from non-launch activities and plant

8.8.20 SaxaVord Spaceport has committed to meeting boundary noise limits for fixed plant, such that appropriate noise limits derived using BS4142 will be met at all NSRs. This assessment assumes that fixed plant associated with SaxaVord Spaceport will be specified such that the noise limits will be met.

8.8.21 No significant sources of noise are anticipated associated with the Proposed Project apart from noise emission from launch; therefore, noise associated with pre- and post-launch activities will arise only from operation of SaxaVord Spaceport's own plant and has been assessed previously. Orbex PRIME Launch Vehicles will be transported to Launch Pad 3 using a vehicle specified such that it does not result in breaches of BS4142-derived noise limits at NSRs.

8.8.22 The resultant worst-case predicted specific noise level at the closest receptor, NSR1, is 24 dB. In accordance with the BS4142 method, noise from fixed plant is not anticipated to include audible tonal, intermittent or impulsive characteristics, therefore the rating level is equal to the specific level, 24 dB.

8.8.23 With reference to Section 8.5, the typical background noise level in the vicinity of the Proposed Project is 22 dB. This level is representative of both the daytime period and the night-time period and is objectively a very low background level. In accordance with BS4142, whereby a rating noise level of less than five dB above the background level is indicative of a low impact, the noise limit for fixed and mobile plant at NSR1 is 27 dB.

8.8.24 The predicted worst-case rating level for fixed and mobile plant of 24 dB is 3 dB below the derived noise limit. Referring to Table 8.5, the impact magnitude is therefore low. With reference to Table 8-7, the resultant effect significance is slight. At more distant NSRs the rating level will be lower, and the result effect significance will be similar or lower than at NSR1. Noise effects associated with fixed and mobile plant at NSR1 are therefore not significant, resulting in no likely significant effect.

Road traffic noise

8.8.25 Projected traffic flows associated with SaxaVord Spaceport total 81 vehicle movements per day, based on an average of monthly traffic movements. This assessment assumes that projected movements for SaxaVord Spaceport include movements associated with the Proposed Project.

8.8.26 Noting that:

- The 2019 estimated flow at the closest Department for Transport (DfT) monitoring location to the Proposed Project, located on the A968 near the centre of Unst, is 494 (details of the DfT data are provided in Volume IV Appendix 8.4);
- This is below the 1,000 vehicle movements per day minimum threshold for the calculation of noise for low traffic flow roads provided in CRTN. Baseline traffic flows are therefore considered to be 'very low';
- An increase of 81 vehicle movements per day represents an increase of 16% over baseline flows and corresponds to an increase in road traffic noise of approximately 1 dB or lower; and
- Most of the vehicle movements will be associated with daily operation of SaxaVord Spaceport and the Proposed Project will comprise a small number of vehicle movements per launch.

8.8.27 This assessment considers that road traffic movements associated with launches were factored into the total provided for the SaxaVord Spaceport AEE and no additional movements would arise associated with the Proposed Project.

8.8.28 Referring to Table 8-3 the impact magnitude of operational road traffic noise is negligible, and the resultant effect significance is neutral. Road traffic noise effects during the operational phase are therefore not significant, resulting in no likely significant effect.

Vibration from engine tests and launches

8.8.29 Predicted unweighted L_{max} noise contours associated with launches are provided in Drawing 8.4. There are no NSRs within the 120 dBL_{max} contours, and only two NSRs (one representative NSR, two properties in total) within the 111 dB contour for launches, with the remainder of NSRs lying outside the 111 dB contour. With reference to Table 8-6 the impact magnitude ranges from negligible to low. Referring to Table 8-7 the resultant significance of effect ranges from neutral to slight and is therefore not significant, resulting in no likely significant effect.

8.9 Additional Mitigation

8.9.1 As there are no likely significant effects, no additional mitigation is required.

8.10 Residual Effects

8.10.1 No additional mitigation is proposed, beyond the committed standard mitigation measures. Residual effects associated with operations remain unchanged resulting in no likely significant effect.

8.11 Cumulative Assessment

8.11.1 There are no intra-project cumulative effects that have the potential to result in significant effects and so no intra-project cumulative assessment is required.

8.11.2 This assessment considers up to ten launches of the Orbex PRIME Launch Vehicle per year which will make up one fifth of SaxaVord Spaceport's own environmental budget of 30 launches per year. The primary noise metric (L_{den}) considers cumulative annual noise and cannot meaningfully be applied to the Proposed Project in isolation; cumulative inter-project effects from other launches taking place at SaxaVord Spaceport have therefore been inherently considered within the assessment.

8.11.3 Shetland Islands Council confirmed during the planning application for SaxaVord Spaceport that there were no other committed development or infrastructure projects which needed to be considered in that assessment and there has been no change subsequent to planning consent. As such, as far as the Applicant is aware, there are no like for like or similar projects within the noise study area and therefore, no significant issues are likely to arise from developments other than SaxaVord Spaceport.

8.12 Summary

8.12.1 Potential noise and vibration effects associated with the Proposed Project have been assessed with regard to launches and associated non-launch activities.

8.12.2 The assessment of noise and vibration relies primarily on modelling and calculations undertaken by BRRC.

8.12.3 Noise effects associated with road traffic and non-launch activities have been assessed as not significant, resulting in no likely significant effect.

8.12.4 Noise during engine tests (should they occur – not currently planned) and launches will be audible at NSRs within and beyond the EZI and levels will exceed the criterion for community annoyance associated with aircraft noise. Instantaneous noise levels will be below the threshold at which damage to hearing may occur.

8.12.5 The short duration of audible noise 'events' associated with engine tests and launches, and their infrequent occurrence, will reduce the associated levels of annoyance to below that which may be associated with aircraft noise from conventional airports. Accordingly, adverse health effects are not anticipated. Noise at NSRs associated with launches is below the level at which the potential for cosmetic damage to structures is likely. Noise effects launches have therefore been assessed as not significant, resulting in no likely significant effect.

8.12.6 Vibration (air overpressure) associated with launches has been evaluated and found to result in a low likelihood of damage complaints and has therefore been determined to be not significant, resulting in no likely significant effect.

8.12.7 Standard mitigation has been considered in the derivation of effect significance. Committed mitigation measures include a commitment to meeting noise limits for fixed and mobile plant items and assisting SaxaVord Spaceport in maintaining good communications with the local community with regard to all activities of the Proposed Project.

8.13 References

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Chapter 9 Accidents and Disasters

9. Major Accidents and Disasters

9. Major Accidents and Disasters

9.1 Introduction

9.1.1 This chapter considers the potential for the Proposed Project to cause major accidents or be affected by natural disasters, in both cases focussing on where harm to the environment as a consequence could reasonably occur.

9.1.2 The assessment is intended to inform management and mitigation of risks to the environment. It does not assess the probability of any major accident or disaster.

9.1.3 The chapter considers environmental hazards inherent to the Proposed Project, the receptor groups likely to be affected in the event of an accident event or disaster, and the potential severity of the impact. The management of these risks by design or further mitigation is discussed.

9.1.4 The chapter considers significant effects from major accidents and natural disasters, it does not represent an exhaustive treatment of every possible risk of environmental damage. “major” is in this context defined as having the potential to cause permanent or long-term damage to a receptor, including loss of life or permanent destruction of habitat. Environmental hazards have been identified in collaboration with the Applicant and through co-operation with SaxaVord Spaceport.

9.2 Legislation and Guidance

Legislation

9.2.1 The treatment of major accidents and disasters within an AEE is a requirement since the Space Industry Regulations 2021 came into force. Guidance document ‘Guidance for the Assessment of Environmental Effects’ (CAA et. al., 2021) states in paragraph 4.65:

‘*The AEE must include a description of the environmental effects of reasonable worst-case scenarios from accidents and disasters which could occur during, or as a result of, the proposed activities. These must include as a minimum:*

- *Possible off-nominal launch scenarios, account for where these occur (for example, on the launch pad)*
- *Fuel and hazardous material storage and handling (for example, failure of containment).’*

9.2.2 The Proposed Project will be a workplace and The Health and Safety at Work Act (1974) (UK Government, 1974) and Management of Health and Safety at Work Regulations (1999) (UK Government, 1999) will apply. The Act’s position on controlling risks, as interpreted by the Health and Safety Executive, to a level “As Low as Reasonably Practical (ALARP)” informs the approach to mitigation in the AEE Report context.

9.2.3 The Control of Major Accident Hazards Regulations (2015) (COMAH) (UK Government, 2015) and the Town and Country Planning (Hazardous Substances)(Scotland) Regulations 2015 (Scottish Government, 2017) will not apply to the Proposed Project as the thresholds for storage of the relevant hazardous materials (principally liquified petroleum gas - LPG) will not be exceeded.

Guidance

9.2.4 Specific guidance for the production of Accidents chapters for AEE is currently limited and therefore reference has been made to examples of current practice shared by the Institute of Environmental Management and Assessment (IEMA, 2020).

9.2.5 The Health and Safety Laboratory (HSL) has produced the guidance document "Safety at Spaceports" (Health and Safety Laboratory, 2018) on behalf of the Civil Aviation Authority and the UK Space Agency. This assessment recognises this guidance and sets out a list of potential hazard areas to examine the potential environmental effects as the guidance suggests. The HSL guidance then recommends a tiered risk assessment process tailored more towards the protection of occupational groups, and as such diverges from the AEE process. This element of the risk assessment is therefore included separately in the Spaceport licence application safety case.

9.3 Assessment Methodology and Significance Criteria

9.3.1 Under the guidance and regulations accompanying the Space Industry Act 2018, a safety case and quantitative operational risk assessments is required to be produced by the Applicant for approval by the regulator. This assessment for AEE does not replace these requirements but rather separately considers reasonably realistic accident and disaster events in the context of their environmental consequences. It would be unrealistic to exclude workers and nearby residents as receptor groups from this assessment however, since any environmental changes would affect these groups as well as potentially wildlife and habitat sites.

9.3.2 A list of potential major accident and disaster events has been drafted on the basis of the Proposed Project's potential vulnerabilities and a range of reasonably plausible accident scenarios developed in consultation with the Applicant.

9.3.3 Events which could potentially meet the definition were considered in terms of the nature of the potential environmental effects, the potential severity and significance of the effect and the requirements for mitigation.

9.3.4 The meaning of "major" should be understood in the context of the Proposed Project. The "major" events assessed are expected to represent the potential events with the highest severity before, during and after the launch of the Orbex PRIME Launch Vehicle. These "major" events would not necessarily be considered as such in the context of a much larger aerodrome or a facility which stored or used flammable materials in far greater quantities such as a petrochemical refinery.

9.3.5 For context, 10 launches per year are proposed by the Applicant.

Environmental Zone of Influence

9.3.6 A one-kilometre buffer area around Launch Pad 3 has been considered for the potential effects of loss of containment and combustion events because effects meeting the definition of a major accident or disaster would be unlikely beyond this distance. Aeronautical events are treated in terms of a ground strike on Unst or a water strike downrange, beyond the stated one-kilometre buffer. The accidents study area buffer is contained within the environmental zone of influence for the Proposed Project.

Assessment of Significance

9.3.7 Potential effect significance must be understood in the context of major accidents and disasters. These are inherently rare events, and it is entirely plausible that no major accident or disaster befalls any launch event. Even if such an event took place, it is also plausible that there might be no effects beyond the immediate vicinity of the Proposed Project and within the boundary of SaxaVord Spaceport.

9.3.8 The terminology used in the assessment, to be consistent with other chapters of the AEE Report and, notwithstanding the caveat in the above paragraph, are as follows:

- Sensitivity – all potential human, wildlife and habitat receptors are assumed highly sensitive on a precautionary basis;
- Magnitude of impact –The usual terminology for the significance of effect is irrelevant in this case as only events with potential for high impacts (loss of life or permanent damage to habitats) are considered; and,
- Significance of effect – Although receptors are assumed to all be of high sensitivity and impacts inherently large and adverse, the significance will still vary depending on the nature of the effect, particularly in terms of duration and reversibility. For instance, a catastrophic release of a toxic fluid could have a major effect on a human receptor, with the potential for fatality, but a minor effect on a habitat which could readily regenerate following brief exposure. The scale of significance used, in descending order, is major, moderate, minor and negligible, with major and moderate being considered as significant effects in terms of AEE.

Requirements for Mitigation

9.3.9 Mitigation of the risk of significant adverse environmental effects is generally embedded in the design of the Proposed Project as influenced by iterative hazard identification exercises.

Assessment of Residual Effect Significance

9.3.10 The residual effects are intended to be the management of the risk of a major accident or disaster to a level that is ALARP, noting that this AEE Report represents a high-level assessment of such risks, with further assessment undertaken elsewhere in the Launch Operator Licence application.

Limitations to Assessment

9.3.11 The assessment is qualitative. It includes no probabilistic treatment of risk, simply identifying plausible major accident and disaster events and commenting on their potential severity and the outline approach to mitigation. It purposely considers environmental effects as its focus, and where effects on human health are noted, it is not intended to substitute for current and future safety case development.

9.4 Baseline Conditions

9.4.1 Baseline conditions are assumed to be routine Orbex PRIME Launch Vehicle operations at SaxaVord Spaceport, rather than any physical description.

9.5 Receptors Brought Forward for Assessment

9.5.1 The following receptors have been brought forward for assessment:

- Habitats within a one-kilometre radius of the launch site were reviewed. Norwick Site of Special Scientific Interest (SSSI) is a geological designation and not considered sensitive. Norwick Meadows SSSI is a habitat designation for its sand dunes and valley fen which support several plant species of national and international interest.
- Wildlife receptors: The immediate vicinity of the Proposed Project will continue to be populated by species identified in Chapters 5 and 6. These have been treated generically as residents of, or visitors to, the vicinity of the Proposed Project.
- Human receptors: The nearest inhabited receptor points outside of the spaceport boundary are Banks Cottage and the village of Norwick, though both are considerably over one kilometre from the Proposed Project i.e., Launch Pad 3. Employees and Contractors working on the Proposed Project will therefore be the nearest human receptors considered.

9.6 Standard Mitigation

9.6.1 Standard mitigation measures have been informed by the safety case and risk assessment work undertaken as part of the application for launch operator licence. Standard mitigation will include the following:

- Development of the Orbex PRIME Launch Vehicle Safety Case / Operations Manual (ORB-EXT-TN012-PT0.1);
- Compliance with SaxaVord Spaceport procedures including Launch Site Safety User’s Manual (SAXA-GRP-OPS-SSUM-001), Emergency Response Plan and Operational Environmental Management Plan. Third-party documents are reviewed against Applicant documents to identify and resolve any incompatibility before launch campaigns begin.
- Establishment and maintenance of an appropriate exclusion when required;
- Minimal storage of reagents on site in favour of “just-in-time” delivery for any given launch campaign with bulk storage off-site (which will be managed by SaxaVord Spaceport as part of their service offering); and
- Propellant / oxidant transfer and storage on hardstanding with integral containment (i.e. a sump of sufficient volume to contain a spillage and prevent loss to soil or groundwater).

9.7 Potential Effects

9.7.1 Major accident and disaster events which were screened out of assessment are shown in Table 9.1, along with reasons for no further consideration. They are generally natural disasters and extreme weather events with no serious risk of occurrence.

Table 9.1 – Events Screened Out

Event	Reason for screening out
Tectonic activity	British Geological Survey records show no recorded earthquake above 4 local magnitude (“light”) within 50 km of Unst since records began. A (British Geological Survey, 2020).
Extreme temperature	Highly unlikely under the most pessimistic climate change scenarios given the latitude of Unst (see Chapter 4).
Extreme storm	Launches with the potential to be compromised by extreme weather conditions would be postponed until a storm event had passed.
Storm surge (inundation)	Elevation makes inundation highly unlikely. No accounts of storm surge at the Proposed Project launch site.

9.7.2 Climate-related risks are discussed in more detail in Chapter 4.

9.7.3 Events taken forward for assessment are summarised in Table 9.2. The events have been grouped into failure of containment (liquids), failure of containment (gases), ignition (liquids) and off-nominal launch scenarios. The nature of the hazards is discussed in the following sections.

Failure of Containment - Liquids

9.7.4 The Orbex PRIME Launch Vehicle requires liquified petroleum gas (LPG) and liquid oxygen (LOX) as primary fuel and oxidant. LPG is used as the sole fuel for both Orbex PRIME Launch Vehicle stages. No other reactive liquids are present, and resonance ignition is employed to initiate combustion.

9.7.5 The Orbex PRIME Launch Vehicle requires an inventory of LOX. The volume required for a launch event represents less than a full load for a single cryogenic road tanker.

9.7.6 LOX will be tankered to the launch site on a just-in-time basis, in quantities required for a given campaign as per other materials. No more than a single tanker load will be required for each campaign.

9.7.7 Following any loss of containment, LOX would rapidly boil off to atmosphere, but in the seconds following the loss may cause cold stress on infrastructure, liquid and vapour burns, and changes to combustibility of nearby fuels through temporary oxygen enrichment of the atmosphere.

9.7.8 LPG will rapidly vaporise if containment is lost since it must be highly pressurised to exist as a liquid at or around ambient temperatures. Loss of LPG as a liquid is hence not a major consideration for environmental damage and is considered further in the next section on gas containment.

Failure of Containment - Gases

9.7.9 LPG will be delivered on a just-in-time basis by road (and ferry) from the Scottish mainland on a launch campaign basis. The maximum on-site quantity (5,500 kg) represents less than a full load for a road tanker.

9.7.10 Loss of containment, if uncontrolled by the mitigation measures in place at the Spaceport, could potentially come into contact with on-site soil and groundwater but is highly likely to fully vaporise before interacting with the nearby designated habitat site and the wildlife supported.

9.7.11 Propane and butane are both relatively non-toxic and a brief episode of elevated concentrations in ambient air is unlikely to have any long-term effects.

9.7.12 Cylinder quantities of helium will also be present aboard the Orbex PRIME Launch Vehicle. Failure of containment will not conceivably lead to any incident and is noted only in the interests of discussing the complete launch inventory.

9.7.13 There may be potential mechanical effects and risk of harm to occupational groups due to a sudden blast of pressurised gas in the event of a catastrophic cylinder or regulator failure.

Ignition of Flammable Materials

9.7.14 LPG is the only flammable material used in bulk quantities by the Proposed Project. Resonance ignition, which uses no reagents, is used instead of chemical or spark ignition.

9.7.15 Uncontrolled combustion of LPG during delivery or launch vehicle fuelling would result in deflagration rather than explosion and then only if vapour had built up to a concentration above the lower explosive limit (LEL) of 1.9% (butane component) and 2.1% (propane component) in a given volume of air. Fuel venting during loading and pressurisation of the Orbex PRIME Launch Vehicle is a transient event taking place in ambient air rather than an enclosed environment; as such concentrations are unlikely to remotely approach the LELs.

9.7.16 Explosive failure of the fuel tanks aboard the launch vehicle would only be a material concern if a much wider blaze fuelled by a second fuel source somehow affected Launch Pad 3. The exclusive use of this Launch Pad by the Applicant during their campaign, and lack of any flammable substrates in and around the Launch Pad, will provide mitigation of this risk.

9.7.17 The resulting deflagration following ignition of propellant during a launch failure would create a short-lived initial fireball potentially extending several tens of metres from Launch Pad 3, with any residual propellant rapidly burning off as a flash fire under ambient atmospheric pressure.

9.7.18 A pool fire would be unlikely to persist for more than several seconds given the relatively high vapour pressures of the LPG components. A flash fire is hence the more likely outcome in the event of sudden loss of inventory followed by ignition. The relatively small mass of fuel in the system means the effects of an LPG flash fire on receptors are unlikely beyond the Launch Pad 3 infrastructure.

9.7.19 A jet fire caused by rupture of the fuel system and subsequent ignition is highly unlikely to affect receptors beyond the Launch Pad 3 infrastructure, even should the flame length increase to several metres.

9.7.20 Initial blast could affect human and wildlife receptors within the site boundary, with off-site effects much less likely. Residual fires could cause a very short-term episode of high air pollutant concentrations near the blast site and immediate downwind locations – nitric oxide and carbon monoxide concentrations may temporarily increase but not lead to any long-term change or chronic effects.

Off-Nominal Launch

9.7.21 Relatively little empirical data on the environmental effects of directly comparable catastrophic losses of a launch vehicle exist. Research by NASA summarising all available historic data for the accidental and planned test destruction of hydrocarbon-propelled launch vehicles suggests that the initial overpressure wave, which approximately corresponds to the deflagration radius (fireball) decays within tens of metres of the point of ignition (Blackwood, 2015).

9.7.22 The initial deflagration radius is not therefore expected to extend beyond the boundary of the Proposed Project and the duration of any subsequent propellant burn-off would be minimal in the open air.

9.7.23 The working expectation is that the risk of ignition of peat will be low following a propellant deflagration. Very little peat substrate was present around Launch Pad 3 and where found has been removed during the Spaceport construction phase. A peat fire would in any case not be allowed to persist and would be extinguished by the spaceport and municipal fire services.

9.7.24 The loss of all or part of the Orbex PRIME Launch Vehicle to the marine environment is considered in Chapter 10 – Marine and Transboundary Effects. Near-shore effects are not considered further as the customary Notice to Mariners and general low amenity for leisure use of the Lamba Ness peninsula coastline are expected to be adequate safeguards.

9.7.25 All launches of the Orbex PRIME Launch Vehicle will take place in a northerly direction from the launch site and will only be allowed to occur when meteorological conditions are such that no southerly movement of the ORBEX PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences.

9.7.26 The loss of all or part of the Orbex PRIME Launch Vehicle to the terrestrial environment on Unst is not considered significant. Fuels and propellants would be expected to rapidly volatilise leaving no permanent change to the area affected. Any debris would be recovered if considered safe and practicable to do so by SaxaVord Spaceport and the emergency services.

Table 9.2 – Events Assessed

Event	Receptors	Potential Consequences	Significance	Mitigation
Failure of Containment - Liquid				
LPG	Human	Soil and groundwater contamination of a very temporary nature before evaporation.	Minor (Not Significant)	Maintenance regime for storage, transfer and containment equipment under responsibility of SaxaVord Spaceport. Applicant to comply with all SaxaVord Spaceport operational procedures and controls.
Liquid oxygen (LOX)	Human, Wildlife, Habitat	Cryogenic injury and damage to receptors in close proximity to release before rapid evaporation takes place. Temporarily enhanced potential for fire and explosion during evaporation – oxygen enriched atmosphere.	Minor (Not Significant)	
Failure of Containment - Gases				
LPG, cylinder gases	Human, Wildlife.	No major hazard – possibility of asphyxia if release in an indoor environment but not considered realistic for a launch event	Minor (Not Significant)	None required
Ignition of Bulk Flammable Materials				
LPG	Human, Wildlife.	Initial blast could affect human and wildlife receptors within the site boundary, with off-site effects much less likely. Residual fires could cause a very short-term episode of high air pollutant concentrations near the blast site and immediate downwind locations – NOx and CO concentrations may temporarily increase.	Moderate (Significant); Minor (Not Significant) after mitigation	Bulk storage off-site. Fire risk assessment to inform safe working practices around flammable materials under responsibility of SaxaVord Spaceport. Applicant to comply with all SaxaVord Spaceport operational procedures and controls.

Event	Receptors	Potential Consequences	Significance	Mitigation
Off-Nominal Launch				
Orbex PRIME Launch Vehicle crash – ground strike	Human, Wildlife, Habitat	Damage to receptors through impact and LPG, potential ignition of LPG vapour and flammable substrate (peat).	Major (Significant); Minor (Not Significant) after mitigation	All launch trajectories are to the north and have minimal land overflight. Areas around launch pad 3 are not peat rich and some peat has been removed. Propellant and oxidant would rapidly volatilise.
Orbex PRIME Launch Vehicle crash – water strike.	Wildlife, Habitat	Damage to receptors through impact and loss of propellant containment.	Minor (Not Significant)	Marine environment (Chapter 10) concludes this is not significant. Propellant load will be partially combusted and is both highly volatile and insoluble.

9.8 Additional Mitigation

9.8.1 Other than where fluid containment and transfer arrangements are required to limit releases to the environment (noted in Table 9.2 and included within the design as standard mitigation), there are not considered to be further significant environmental risks which require additional mitigation measures. No additional mitigation beyond the measures identified in Section 9.6 are considered necessary.

9.8.2 Inherent safe operating practices are required under CAA licensing requirements. The prevention and mitigation of other accidents and disasters without significant environmental effects will be managed through parallel risk and hazard management processes under CAA licensing i.e., the Orbex PRIME Launch Operations Safety Case.

9.9 Residual Effects

9.9.1 Residual effects are not relevant to the discussion of significant environmental effects of major accidents and disasters as the effectiveness of the proposed mitigation cannot be absolutely guaranteed as these are low-frequency random events.

9.10 Cumulative Assessment

9.10.1 Cumulative effects can be either inter-project or intra-project effects.

9.10.2 Intra-project risks on site will be managed in accordance with CAA licensing requirements and mitigated by use of Exclusion Zones. There are no intra-project cumulative effects that have the potential to result in significant effects and so no intra-project cumulative assessment is required.

9.10.3 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, it is considered that there are no potential inter-project cumulative effects as there are no other existing or proposed developments nearby of relevance. Shetland Islands Council was contacted during the SaxaVord Spaceport planning application stage and confirmed that there are no committed development or infrastructure projects on the Island which should be considered in the assessment.

9.11 Summary

9.11.1 This chapter considers the potential for activities at the Proposed Project to cause major accidents or be affected by natural disasters, in both cases, focussing on where harm to the environment as a consequence could reasonably occur. The assessment is quantitative for the context of an AEE Report and does not examine the probabilities of major accident events and disasters occurring.

9.11.2 A list of potential events was drawn up based on the Proposed Project activities.

9.11.3 Natural disasters including flooding and tectonic activity are considered highly unlikely given the location of the Proposed Project. Extreme weather effects have been addressed in the Climate Change Chapter 4 of this AEE Report, and it is considered that the proposed infrastructure design provides sufficient resilience to the effects of extreme weather events over the design life of the Proposed Project.

9.11.4 Accident events were subcategorised into failure of containment of propellant and fuel, ignition of fuel and off-nominal launch scenarios. The effects on generic on-site human and wildlife receptors and off-site designated habitat sites were considered for each of these events.

9.11.5 Failures of containment were generally considered to be minor or moderate significance and largely restricted to the areas immediately within the vicinity of the release point, given the quantities in use and the rapid expected evaporation and/or dispersion of the liquids and gases used. Mitigation will be through adherence to the Applicant's own and SaxaVord Spaceport management procedures, robust containment and restrictions on the quantities stored at the Proposed Project site.

9.11.6 Again, noting the environmental context, ignition events are considered to be major with potential for significant effects inasmuch as damage to health or loss of life to human and wildlife receptors would be possible if in close proximity to the event. In the unlikely event that ignition of LPG vapour occurred, the deflagration radius or resulting jet or flash fire would be relatively small (likely within the spaceport boundary) and the subsequent blaze limited in duration by the quantities stored and used. Mitigation will be through the restriction of ignition sources from flammable materials through standard operating practices. Uncontrolled ignition events during launches will be managed through the Orbex PRIME Launch Vehicle design process and integrity checks.

9.11.7 Off-nominal launch scenarios are considered to be of major significance should a ground strike take place, with potential for severe damage to human, wildlife and habitat receptors from impact and subsequent ignition of remaining propellant. Mitigation is inherent to the remote, northerly location of the Proposed Project and exclusively northward launch trajectories to be used. Water strikes were considered of moderate significance as wildlife and marine habitat receptors could potentially be impacted and are discussed in the Marine Effects Chapter (Chapter 10) of this AEE Report.

9.12 References

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Chapter 10 Marine and Transboundary

10. Marine and Transboundary Effects

10. Marine & Transboundary Effects

10.1 Introduction

10.1.1 This chapter considers the marine and transboundary effects from the Proposed Project.

10.1.2 Transboundary effects of the Proposed Project are environmental effects that may arise in a different country as a consequence of the Proposed Project.

10.1.3 The majority of the potential environmental effects are expected at or near the Proposed Project. However, Orbex PRIME Launch Vehicles will also splashdown in territorial and international waters and potentially interact with the marine environment. The scope of the transboundary effects chapter is therefore concerned with assessment of the marine environmental effects of returning Orbex PRIME Launch Vehicle stages and associated debris. This chapter considers the potential marine receptors present within the effects range of the predicted impact points from returning Orbex PRIME Launch Vehicles for both sub-orbital and orbital campaigns.

10.1.4 The UK Government has consulted with the governments of countries where the first stage, interstage and fairings of the Orbex PRIME Launch Vehicle are predicted to land to come to an agreement to allow stages to fall in their waters (SaxaVord Spaceport, 2020). However, when considering the second stage, the South Pacific EZI of the Orbex PRIME Launch Vehicle may overlap with the Exclusive Economic Zones (EEZs) of other countries. In such cases, the second stage will not be released on any trajectory where it will fall within the EEZs of any of these nations unless prior permission is obtained pertinent to the specific launch.

10.2 Legislation, Policy and Guidelines

Legislation and Guidance

10.2.1 This Assessment of Environmental Effects has been produced under the Space Industry Act 2018, as transposed into The Space Industry Regulations 2021. It has been informed using:

- Guidance to the Regulator on Environmental Objectives Relating to the Exercise of its Functions under the Space Industry Act 2018; and
- Guidance for the Assessment of Environmental Effects 2021.

Planning Policy

10.2.2 The launch aspect of Scotland's space sector is emergent in nature. As such developments occur only on land, the space sector has not been considered in marine planning policy such as Scotland's National Marine Plan (Scottish Government, 2015). Despite not being considered as a specific activity in Scotland's National Marine Plan (the Plan), policies are included in the Plan that may need consideration when assessing the Proposed Project. In order to address this potential, the Plan policies have been reviewed (Appendix 10.1) and screened to determine which of the policies are of relevance to the Proposed Project. Where policies are considered relevant, the related sections of the AEE have been signposted (Table 10.1) to ensure that the content of the AEE demonstrates due consideration of the issues highlighted by the Plan policies.

10.2.3 The screening of policies for relevance to the Proposed Project considered if the Plan policies were sector specific and therefore not relevant, or if the Plan policies related to a specific geographic location and were therefore not relevant to the Proposed Project. The reason for not including policies in the process is noted in the summary table presented in Appendix 10.1.

10.2.4 The results of the Plan policy review and screening process indicate that the following policies are of relevance to the marine environment and the Proposed Project:

- GEN 1 General planning principle;
- GEN 2 Economic benefit;
- GEN 3 Social benefit;
- GEN 4 Co-existence;
- GEN 5 Climate change;
- GEN 6 Historic environment;
- GEN 7 Landscape/seascape;
- GEN 8 Coastal process and flooding;
- GEN 9 Natural heritage;
- GEN 11 Marine litter;
- GEN 12 Water quality and resource;
- GEN 13 Noise;
- GEN 14 Air quality;
- GEN 15 Planning alignment A;
- GEN 17 Fairness;
- GEN 18 Engagement;
- GEN 19 Sound evidence;
- GEN 20 Adaptive management;
- GEN 21 Cumulative impacts;
- FISHERIES 1, 2 and 3;
- WILDFISH 1;
- OIL & GAS 4, 5, and 6; and
- TRANSPORT 1, 3 and 6.

10.2.5 Table 10.1 lists these Plan policies and indicates the chapter of the AEE where information is presented to account for the requirements of the policy.

Table 10.1 Scotland National Marine Plan policies and cross-reference to section where information is presented to account for the requirements of the policies

Policy ID	Policy Text	Relevant Chapter(s)
GEN 1	*There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.*	Chapter 10
GEN 2	*Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.*	Chapter 10
GEN 3	*Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.*	Chapter 10
GEN 4	*Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision-making processes, when consistent with policies and objectives of this Plan.*	Chapter 10
GEN 5	*Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.*	Chapter 4
GEN 6	*Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.*	Chapter 10
GEN 7	*Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account.*	Chapter 2
GEN 8	*Developments and activities in the marine environment should be resilient to coastal change and flooding and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.*	Chapter 4
GEN 9	*Development and use of the marine environment must:* *(a) Comply with legal requirements for protected areas and protected species.* *(b) Not result in significant impact on the national status of Priority Marine Features.* *(c) Protect and, where appropriate, enhance the health of the marine area.*	Chapter 10

Policy ID	Policy Text	Relevant Chapter(s)
GEN 11	*Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.*	Chapter 10
GEN 12	*Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.*	Chapter 10
GEN 13	*Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.*	Chapter 8
GEN 14	*Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.*	Chapter 7
GEN 15	*Marine and terrestrial plans should align to support marine and land-based components required by development and seek to facilitate appropriate access to the shore and sea.*	Chapter 10
GEN 17	*All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.*	Chapter 10,
GEN 18	*Early and effective engagement should be undertaken with the general public and all interested stakeholders to facilitate planning and consenting processes.*	Chapter 10
GEN 19	*Decision making in the marine environment will be based on sound scientific and socio-economic evidence.*	Chapter 10
GEN 20	*Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy.*	Chapter 10
GEN 21	*Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.*	Chapter 10

Policy ID	Policy Text	Relevant Chapter(s)
FISHERIES 1	*Taking account of the EU's Common Fisheries Policy, Habitats Directive, Birds Directive and Marine Strategy Framework Directive, marine planners and decision makers should aim to ensure:* - *Existing fishing opportunities and activities are safeguarded wherever possible.* - *An ecosystem-based approach to the management of fishing which ensures sustainable and resilient fish stocks and avoids damage to fragile habitats.* - *Protection for vulnerable stocks (in particular for juvenile and spawning stocks through continuation of sea area closures where appropriate).* - *Improved protection of the seabed and historical and archaeological remains requiring protection through effective identification of high-risk areas and management measures to mitigate the impacts of fishing, where appropriate.* - *That other sectors take into account the need to protect fish stocks and sustain healthy fisheries for both economic and conservation reasons.* - *Delivery of Scotland's international commitments in fisheries, including the ban on discards.* - *Mechanisms for managing conflicts between fishermen and/or between the fishing sector and other users of the marine environment.*	Chapter 10
FISHERIES 2	*The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on fishing:* - *The cultural and economic importance of fishing, in particular to vulnerable coastal communities.* - *The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area.* - *The environmental impact on fishing grounds (such as nursery, spawning areas), commercially fished species, habitats and species more generally.* - *The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.*	Chapter 10
FISHERIES 3	*Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake*	Chapter 10

Policy ID	Policy Text	Relevant Chapter(s)
	to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted. *The content of the Strategy should be relevant to the particular circumstances and could include:* - *An assessment of the potential impact of the development or use on the affected fishery or fisheries, both in socio-economic terms and in terms of environmental sustainability.* - *A recognition that the disruption to existing fishing opportunities/activity should be minimised as far as possible.* - *Reasonable measures to mitigate any constraints which the Proposed Project or use may place on existing or proposed fishing activity.* - *Reasonable measures to mitigate any potential impacts on sustainability of fish stocks (e.g., impacts on spawning grounds or areas of fish or shellfish abundance) and any socio-economic impacts.* *Where it does not prove possible to agree the Strategy with all interests, the reasons for any divergence of views between the parties should be fully explained in the Strategy and dissenting views should be given a platform within the Strategy to make their case.*	
WILD FISH 1	*The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision-making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making.*	Chapter 10
OIL & GAS 4	*All oil and gas platforms will be subject to 9 nautical mile consultation zones in line with Civil Aviation Authority guidance.*	Chapter 10
OIL & GAS 5	*Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.*	Chapter 10

Policy ID	Policy Text	Relevant Chapter(s)
OIL & GAS 6	*Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.*	Chapter 10
TRANSPORT 1	*Navigational safety in relevant areas used by shipping now and in the future will be protected, adhering to the rights of innocent passage and freedom of navigation contained in UN Convention on the Law of the Sea (UNCLOS). The following factors will be taken into account when reaching decisions regarding development and use:* - *The extent to which the locational decision interferes with existing or planned routes used by shipping, access to ports and harbours and navigational safety. This includes commercial anchorages and defined approaches to ports.* - *Where interference is likely, whether reasonable alternatives can be identified.* - *Where there are no reasonable alternatives, whether mitigation through measures adopted in accordance with the principles and procedures established by the International Maritime Organization can be achieved at no significant cost to the shipping or ports sector.*	Chapter 10
TRANSPORT 3	*Ferry routes and maritime transport to island and remote mainland areas provide essential connections and should be safeguarded from inappropriate marine development and use that would significantly interfere with their operation. Developments will not be consented where they will unacceptably interfere with lifeline ferry services.*	Chapter 10
TRANSPORT 6	*Marine planners and decision makers and developers should ensure displacement of shipping is avoided where possible to mitigate against potential increased journey lengths (and associated fuel costs, emissions, and impact on journey frequency) and potential impacts on other users and ecologically sensitive areas.*	Chapter 10

10.2.6 In addition to the policies in Scotland's National Marine Plan, the Shetland Local Development Plan (the Shetland Plan) (Shetland Islands Council, 2014) has also been reviewed to determine if any policies exist that may be relevant to the Proposed Project. The Shetland Plan outlines several policies that must be considered in applications for new development. The policies that are of relevance to the marine environment and the Proposed Project include:

- NH2 Protected Species;
- NH3 Furthering the Conservation of Biodiversity; and
- NH 7 Water Environment; and
- HE4 Archaeology.

10.2.7 Table 10.2 lists these Shetland Plan policies and indicates the chapter of the AEE where information is presented to account for the requirements of the policy. Further information is presented in Appendix 10.1.

Table 10.2 Shetland Local Development Plan policies and cross-reference to section where information is presented to account for the requirements of the policies

Policy ID	Policy Text	Relevant Chapter(s)
NH 2	*"Where there is good reason to suggest that a species protected under the Wildlife and Countryside Act 1981 (as amended), Annex IV of the Habitats Directive or Annex 1 of the Birds Directive is present on site, or may be affected by a Proposed Project, the Council will require any such presence to be established. If such a species is present, a plan should be provided to avoid or mitigate any adverse impacts on the species, prior to determining the application.* *Planning permission will not be granted for development that would be likely to have an adverse effect on a European Protected Species unless the Council is satisfied that:* *• The development is required for preserving public health or public safety or for other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment; and* *• There is no satisfactory alternative; and* *• The development will not be detrimental to the maintenance of the population of the European Protected Species concerned at a favourable conservation status in their natural range.* *Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedule 5 (animals) or 8 (plants) of the Wildlife and Countryside Act 1981 (as amended) unless the Council is satisfied that:* *• Undertaking the development will give rise to, or contribute towards the achievement of, a significant social, economic or environmental benefit; and* *• There is no satisfactory solution.* *Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedules 1, 1A or A1 (birds) of the Wildlife and Countryside Act 1981 (as amended), unless the Council is satisfied that:* *• The development is required for preserving public health or public safety; and*	Chapter 10

Policy ID	Policy Text	Relevant Chapter(s)
	• There is no other satisfactory solution. *Applicants should submit supporting evidence for any development meeting these criteria, demonstrating both the need for the development and that a full range of possible alternative courses of action have been properly examined and none found to acceptably meet the need identified.* *The Council will apply the precautionary principle where the impacts of a Proposed Project on natural heritage are uncertain but potentially significant. Where development is constrained on the grounds of uncertainty, the potential for research, surveys or assessments to remove or reduce uncertainty should be considered. "*	
NH 3	*"Development will be considered against the Council's obligation to further the conservation of biodiversity and the ecosystem services it delivers. The extent of these measures should be relevant and proportionate to the scale of the development.* *Proposals for development that would have a significant adverse effect on habitats or species identified in the Shetland Local Biodiversity Action Plan, Scottish Biodiversity List, UK Biodiversity Action Plan, Annexes I and II of the Habitats Directive, Annex I of the Birds Directive (if not included in Schedule 1 of the Wildlife and Countryside Act) or on the ecosystem services of biodiversity, including any cumulative impact, will only be permitted where it has been demonstrated by the developer that;* • *The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of habitat or populations of species; and* • *Any harm or disturbance to the ecosystem services, continuity and integrity of the habitats or species is avoided or reduced to acceptable levels by mitigation."*	Chapter 10
NH 7	*"Development will only be permitted where appropriate measures are taken to protect the marine and freshwater environments to an extent that is relevant and proportionate to the scale of development. Development adjacent to a watercourse O or water body must be accompanied by sufficient information to enable a full assessment of the likely effects.*	Chapter 10

Policy ID	Policy Text	Relevant Chapter(s)
	Where there is potential for the development to have an adverse impact the applicant/developer must demonstrate that: • *There will be no deterioration in the ecological status of the watercourse or water body;* • *It does not encroach on any existing buffer strips and that access to these buffer strips has been maintained; and* • *Both during the construction phase and after completion it would not significantly affect:* o *Water quality flows in adjacent watercourses or areas downstream* o *Natural flow patterns and sediment transport processes in all water bodies or watercourses."*	
HE 4	*"Scheduled monuments, designated wrecks and other identified nationally important archaeological resources should be preserved in situ, and within an appropriate setting. Developments that have an adverse effect on scheduled monuments and designated wrecks or the integrity of their settings should not be permitted unless there are exceptional circumstances.* *All other significant archaeological resources should be preserved in situ wherever feasible. Where preservation in situ is not possible the planning authority should ensure that developers undertake appropriate archaeological excavation, recording,* *analysis, publication and archiving in advance of and/ or during development."*	Chapter 10

10.3 Consultation

10.3.1 Extensive consultation on the scope of the Marine Environmental Risk Assessment (MERA) matters was carried out during preparation and determination of the planning application for SaxaVord Spaceport, from where the Proposed Project will operate. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 10.3.

Table 10.3 SaxaVord Spaceport Consultation Responses directly relevant to this AEE

Consultee and Date	Issue Raised	Response/Action Taken
Marine Scotland 28/05/2020	*The Marine Scotland Licensing Operations Team do not have anything to add in relation to the planning or construction aspects of the Space Centre, nor are we suitably placed to inform you as to what should or should not be scoped into your MERA. However, you should ensure we are contacted regarding marine licensing requirements of launch activities taking place at the Space Centre.* *We would also recommend that you consult with the MMO (Marine Management Organisation) to confirm whether or not there are any further UK licensing requirements.*	A response was provided by email to assure that marine licensing requirements had already been discussed and addressed, and that these did not fall within the scope of the MERA. The MMO were consulted with (see below).
Scottish Environmental Protection Agency (SEPA) 17/06/2020	*The information provided suggest that marine issues appear to be further away offshore and is therefore not within SEPA's remit to provide advice.* *Following your statement in the email below; it is unfortunate that the proposals seem to be one that would be polluting the marine environment especially the Arctic as it is stated that, it is not expected that any part of the launch vehicles will be retrieved.* *In regard to the impact on the marine environment, it appears the 4 bullet points that have been scoped out would need to be considered because planned launches which go wrong may end up landing in the waters close to Marine Protected Areas (MPA) and offshore oil platforms rather than in the arctic.*	Acknowledged. As assessed in the MERA, the impact is predicted to be minor at worst. The 4 bullet points to which the email refers (offshore marine protected areas; offshore renewable developments; offshore oil and gas platforms; aggregated extraction areas) were characterised as part of the baseline for the North Atlantic EZI in Section 10.6. The North Atlantic EZI encompasses the launch site, so as to be precautionary about where the impact zones will be.
Royal Society for the Protection of Birds (RSPB) 03/06/2020	*We feel that consideration of the assessment approach required for the return of parts of launch vehicles to the marine environment is somewhat outwith our expertise. However, in general terms, looking at the receptors that you intend to scope in, my opinion would be that you seem to be covering all relevant factors. Also, the receptors being scoped out seem acceptable.*	Acknowledged; no further action required.

Consultee and Date	Issue Raised	Response/Action Taken
Maritime and Coastguard Agency (MCA) [Offshore Renewables Advisor] 03/06/2020 and 04/06/2020 [via phone discussion]	A series of clarification queries were raised by the MCA via return email. Issues raised in relation to the MERA included: *Have the scoped-out receptors been checked with current datasets?* *Will 'Shipping Activities' cover all vessel types; recreational, fishing, commercial and other offshore users including oil and gas, and dredging?* *Has vessel traffic been assessed in the study area to make this conclusion [that in-combination effects can be ruled out]?*	Clarification was provided via a phone call on 04/06/2020. The scoped-out receptors were characterised as part of the baseline for the North Atlantic EZI in Section 10.6. Shipping activities, characterised in Section 10.6, have assessed all vessel types. Vessel traffic has been described in Section 10.6 and assessed in Section 10.10. Effects on shipping and navigation have been considered in the cumulative assessment in Section 10.13.
09/09/2020 [via email]	*Based on [the further information provided in response to previous questions], I believe (at this point) that the impact on shipping and navigation should be suitably addressed through your approach to the MERA. I can only respond within the MCA's remit and you will of course need to consult with other interested parties to ensure nothing has been omitted from the approach.*	Acknowledged, no further action required.
Marine Management Organisation (MMO) 29/05/2020 [via phone discussion]	*Enquiries with regards to marine licensing should be submitted through our online marine licensing portal the Marine Case Management System (MCMS).*	A response was provided by email to assure that marine licensing requirements had already been discussed and addressed, and that these did not fall within the scope of the MERA

10.4 Scope of Assessment

Environmental Zone of Influence

10.4.1 The proposed trajectories of both sub-orbital and orbital launches of the Orbex PRIME Launch Vehicle will have an overall northerly direction from SaxaVord Spaceport, contained between 085 and 100 degrees from the equator. Considering the impact zone for the payload fairing, up to three impact zones are expected per launch (first stage plus interstage, fairings, and second stage). The impact zones for the first stage, interstage and fairings are expected to occur in marine locations between Scotland and Greenland. The impact zone for the deorbiting second (orbital) stage is anticipated to occur in the South Pacific. The resultant study areas for all launches, termed the environmental zone of influence (EZI), is presented across Drawings 10.1 (North Atlantic EZI) and 10.2 (South Pacific EZI).

10.4.2 The North Atlantic EZI falls within the jurisdiction of several countries including Scotland, Norway, Faroe Islands (Denmark), and Jan Mayen (Iceland). The North Atlantic EZI lies mostly within OSPAR Region 1: Arctic Waters, with the waters up to 200 km north of Shetland falling within Region II: Greater North Sea (OSPAR, 2020).The South Pacific EZI overlaps with the EEZs of a number of Pacific Island nations, however this stage will not be released on any trajectory where it will fall within the EEZs of any of these nations, unless prior permission is obtained pertinent to the specific launch. The South Pacific EZI also falls within areas beyond national jurisdiction.

10.4.3 Orbital and sub-orbital launches are predicted to occur from Launch Pad 3 at SaxaVord Spaceport. The impact dispersion area from Launch Pad 3 for both sub-orbital and orbital launches is demarcated in Drawing 10.2. This assessment considers the potential effects of orbital launches of the Orbex PRIME Launch Vehicle as a precautionary measure, as these are predicted to have greater effects across all impact pathways.

10.4.4 The trajectory and likely impact zone for returning material from sub-orbital launches is spatially limited compared to orbital launches, as sub-orbital launches have a reduced range. The area of impact for sub-orbital launches is encompassed within the larger EZI.

10.4.5 Sub-orbital launches will take place along a northerly azimuth (089.50° from the equator) from the launch site and will only be allowed to occur when meteorological conditions are such that no southerly movement of the Orbex PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences.

Desk Study

10.4.6 This assessment comprises a desk study. The primary resources used to inform this chapter include:

- OSPAR resources;
- Conservation of Arctic Flora and Fauna (CAFF) 2017 State of the Arctic Marine Biodiversity Report;
- National Oceanic and Atmospheric Administration (NOAA) resources;
- European Marine Observation and Data network (EMODnet);

- ICES landings data;
- National Biodiversity Network (NBN) Atlas;
- NatureScot resources;
- Marine Scotland resources, including the National Marine Plan interactive viewer;
- Consultation responses;
- Project-specific Navigational Risk Assessment; and
- Published and unpublished literature.

10.5 Assessment Methodology

10.5.1 To assess the level of potential impact (likely significant effects) resulting from launch events at the Proposed Project, a methodology has been developed to establish the level of environmental risk of the Proposed Project to a range of receptors. This takes account of the sensitivity of the receptor, the exposure of the receptor to effects and the magnitude of the effects over and above the baseline condition. Therefore, for the purposes of this assessment, the term 'risk assessment' can be used interchangeably for 'impact assessment'.

10.5.2 More information on the criteria considered when determining levels of sensitivity, exposure and magnitude is provided below. In all cases, the assessment considers impacts, over and above those that may have already occurred, to determine whether the proposal constitutes a significant risk (likely significant effect) to the water quality, biodiversity or human and human activity environment in the vicinity of the EZIs. It should also be noted that where receptors are grouped together, or where a wide range of scores exists, the worst-case scores of sensitivity (comprising worst-case scores of tolerance, adaptability and recoverability), exposure and magnitude are taken for each of the individual receptors.

Criteria Employed to Determine Levels of Sensitivity, Exposure and Magnitude

Sensitivity

10.5.3 The sensitivity assessment used is an assessment of the relative sensitivity of the receptor features within the EZIs to effects associated with returning Orbex PRIME Launch Vehicle components. In relation to this assessment, sensitivity has been defined in terms of the receptor's value (importance, quality and rarity), and as a product of tolerance, adaptability and recoverability to a pressure/effect:

- Tolerance is the susceptibility (ability to be affected or unaffected) of a receptor from an external factor;
- Adaptability relates to the ability of the receptor to adapt to, or avoid, an external factor; and
- Recoverability is the ability of a receptor to return to a state close to that which existed before the activity or event caused change within a specified period of time.

10.5.4 For each receptor, consideration is given to each of these component parts of the sensitivity assessment, with overall sensitivity being governed by the combined scores for each part. The scores for each element range from 0-3 (Negligible to High) and are determined based on consideration of the available evidence.

10.5.5 The sensitivity assessments of the receptors (grouped or their component sub-features) are based upon a series of scientific review documents. These include Tyler-Walters and Hiscock (2005) and the Marine Habitats Reviews (Jones et al., 2000). Further detailed consideration of sensitivity (specifically in the context of benthic receptors but also more widely applicable) is provided at the MarLIN website. (MarLIN, 2019).

10.5.6 A combination of screening against sensitivity criteria per receptor/grouped receptors and expert judgement, based upon supporting statements within the baseline, have then been used to deliver the sensitivity assessment component of the risk assessment.

10.5.7 Where grouped receptors have been used (e.g., for some parts of the benthic ecology assessment), then the receptor with the known highest sensitivity (greatest intolerance) to the pressure assessed has been used as the benchmark. This has allowed a conservative/precautionary assessment process for sensitivity to feed into the risk assessment matrix.

10.5.8 In practice, to determine the sensitivity of a receptor each characteristic (value, adaptability, tolerance and recoverability) is scored from 0-3. In most cases, 0 represents a negligible score whereas 3 will indicate a high value for the characteristic. In the case of recoverability, adaptability, and tolerance, a low score indicates that the receptor is capable of withstanding the impact pressure and should reduce the sensitivity score, whereas a high score for these characteristics will lead to a high sensitivity.

10.5.9 The following limits have subsequently been used to determine whether the sensitivity of the receptor is negligible, low, medium, or high:

Combined Score	Sensitivity
0-3	Negligible (0)
4-6	Low (1)
7-9	Medium (2)
10-12	High (3)

10.5.10 The sensitivity score is then carried forward to the final risk assessment (see below).

Exposure

10.5.11 Exposure is defined in terms of how the impacts affect a receptor, including the spatial extent of the impact, its longevity above baseline levels and the frequency at which the impact occurs.

10.5.12 In practice, to determine the exposure of a receptor to a particular impact, each characteristic (spatial extent, longevity and frequency) is scored from 0-3. The combined scores are then used to determine the level of exposure that a receptor will experience.

10.5.13 The following limits have subsequently been used to determine whether the exposure to the impact is negligible, low, medium or high:

Combined Score	Exposure
0	Negligible (0)
1-4	Low (1)
5-7	Medium (2)
8-9	High (3)

10.5.14 The exposure score is then carried forward to the final risk assessment (see below).

Magnitude

10.5.15 Magnitude is defined in terms of the level of the impact above background conditions and natural variability by whatever parameters are measurable.

10.5.16 In practice, to determine the magnitude of an impact, each characteristic (level above background, level in the context of natural variability) is scored from 0-3. The combined scores are then used to determine the level of exposure that a receptor will experience.

10.5.17 The following limits have subsequently been used to determine whether the magnitude of the impact is negligible, low, medium, or high:

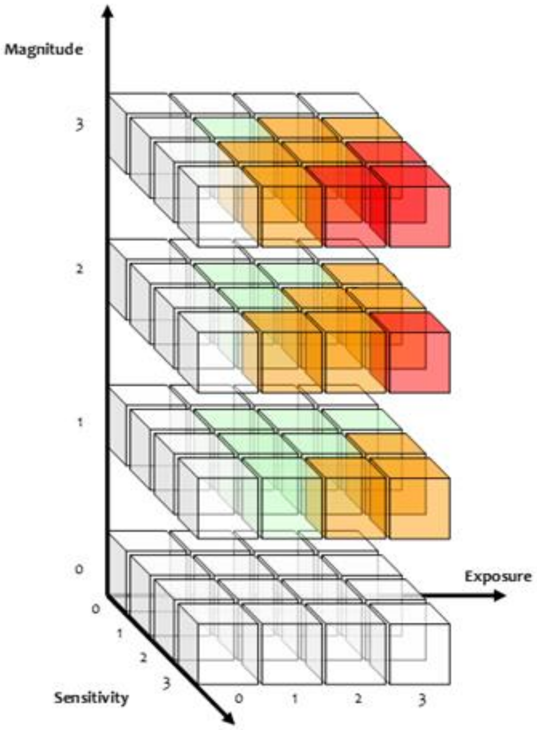
Combined Score	Magnitude
0	Negligible (0)
1-2	Low (1)
3-4	Medium (2)
5-6	High (3)

Summary of Methodology Used to Determine Level of Environmental Risk

10.5.18 As noted, the methodology adopted for this assessment utilises three elements: receptor sensitivity, exposure to impact and the magnitude of impact. As described, limits have been defined to assist in ascribing relevant values to these elements for all the receptors and potential impacts considered. The parameters adopted to ascribe values to the level of sensitivity, exposure, and risk (impact) have been adjusted according to the nature of the receptor and the impact.

Environmental Risk Assessment Matrix

10.5.19 An environmental risk assessment matrix has been developed to determine the risk posed by a range of impacts to a range of receptors. The matrix is illustrated in Figure 10.1. In practice, to determine the level of risk posed by an impact to a receptor, the scores resulting from the assessment outlined above are multiplied to determine the level of risk.



For the purposes of this assessment, the following limits have been set.

Score		Risk Value
0	=	Negligible
1-5.99	=	Low
6-17.99	=	Medium
18-27	=	High

Figure 10.1 The risk assessment matrix

10.5.20 Table 10.4 presents the transposition of the risk values into the terminology used in the wider AEE Report.

Table 10.4 Risk assessment values and transposition into wider AEE Report terminology

Risk Value	AEE terminology	Potential Significant Effect
Negligible	Negligible	No Likely Significant Effect
Low	Minor	No Likely Significant Effect
Medium	Moderate	Likely Significant Effect
High	Major	Likely Significant Effect

10.5.21 It should be noted that broad receptor groups e.g., benthic habitats, are made up of a range of individual receptors e.g., bivalves, polychaetes, corals, sponges etc. As such, the risk assessment has been undertaken to account for the most sensitive elements of the broad receptor groups, with an overall risk summary for each broad group presented in the document.

Requirements for Mitigation

10.5.22 For the purposes of this assessment, risk scores of <6 (Low or Negligible Risk) are considered insignificant, and mitigation is unnecessary as no likely significant effects arise.

10.5.23 Risk scores of 6-17.99 (Medium Risk) are considered to result in likely significant effects. Where mitigation can be applied impacts may be reduced to Low or Negligible Risk resulting in residual effects equating to no likely significant effect. If specific mitigation measures are not applied likely significant effects will remain.

10.5.24 Risk scores ≥18 (High Risk) is considered to result in likely significant effects and impacts are likely to be mitigated only through application of specifically targeted measures and/or acquisition of further environmental information to better determine impact significance. If specific mitigation measures are not applied significant effects will remain.

Assessment of Residual Effect Significance

10.5.25 Where mitigation practices are required to reduce the level of risk to no likely significant effect, these measures are presented along with a subsequent assessment of likely residual effect.

Limitations to Assessment

10.5.26 Following the risk assessment, a consideration of the confidence of the assessment has been undertaken based on the nature of evidence used, and the application of the evidence, to determine the risk of the proposals.

10.6 Baseline Conditions

10.6.1 The baseline conditions are described in terms of their water quality, biodiversity and humans/human activities for the EZIs are discussed in detail in Appendix 10.2.

10.7 Receptors Brought Forward for Assessment

10.7.1 Following characterisation of the baseline, certain receptors have been screened out due to a lack of presence in an EZI and/or pathway of effect.

10.7.2 Physical features have been screened out for the North Atlantic EZIs due to a lack of pathway of any significant effect. Due to the worst-case scenario of potential effects occurring within the North Atlantic EZI, it is assumed that potential effects within the South Pacific EZI will be of lesser extent (limited to effects associated with debris and residual fuel of the second stage returning to Earth). Therefore, the assessment focusses on the North Atlantic EZI.

10.7.3 It is noted that through consultation for SaxaVord Spaceport, the North Sea Transition Authority confirmed that there was negligible risk to the oil and gas surface infrastructure present to the west and north-east of Shetland for the UK Continental Shelf. Any impacts within the South Pacific EZI will be restricted within the EEZ of any country (without prior agreement), therefore there is no likely interaction with marine infrastructure in this area. Should an agreement come into place in future, this will be assessed at that time but is expected to fall under the same mitigation strategy covered by the Flight Termination System. Accordingly, oil and gas surface infrastructure are scoped out of the assessment, for both study areas.

10.7.4 As described in the baseline environment, there is negligible presence of other sea users and socio-economics/tourism in the study area. Accordingly, these human activities have been scoped out for the study area.

10.7.5 Details of which features/receptors are being taken forward for assessment are presented in Table 10.5.

Table 10.5 Receptors taken forward in the assessment

Receptor	Taken Forward
Water and Sediment quality	
Contaminants	Yes
Microplastics	Yes
Biodiversity	
Physical features	No
Plankton	Yes
Benthic species	Yes
Fish and shellfish	Yes
Marine ornithology	Yes
Marine megafauna	Yes
Marine protected area	Yes
Human/human activities	
Shipping and navigation	Yes
Oil and gas infrastructure	No
Cables and pipelines	Yes
Military	Yes
Other sea users	No
Socioeconomics/tourism	No
Marine archaeology	Yes
Commercial fisheries	Yes

10.8 Assessment Envelope

10.8.1 As per the AEE Regulations, the impact assessment should be based on the worst-case parameters, known as the Rochdale envelope.

10.8.2 Certain worst-case scenarios, such as the maximum number of launches or maximum launch vehicle size, are already known and have been set as limits as part of the project design.

10.8.3 A full description of the proposal is provided in Chapter 3 Proposed Project. For completeness, this assessment envelope presents a subset of the project description that is relevant to this chapter.

Launch Vehicles

10.8.4 The effects of the returning Orbex PRIME Launch Vehicle components on the marine environment will depend on the physical properties of the Orbex PRIME Launch Vehicle as well as the marine environmental receptor within the specific EZI. The physical properties of the returning Orbex PRIME Launch Vehicle which may influence the level of effect include aspects such as the amount of residual fuel, the materials present and their reaction in the marine environment, and the dimensions of the components.

10.8.5 The frequency of operations is also relevant to the magnitude of effects. It is noted that there will be a maximum of 10 launches in any given year, and no more than two launches in any given month.

Physical properties

10.8.6 The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure and intended to place customer payloads into both sub-orbital trajectories and sun synchronous (SSO) and polar orbits.

10.8.7 Indicative parameters for the Orbex PRIME Launch Vehicle are summarised in Table 10.6.

Table 10.6 Summary Orbex PRIME Launch Vehicle parameters

Parameters	First Stage	Second Stage	Interstage	Payload Fairings
Maximum height (m)**	13.7 (inc. interstage)	4.6	(included in First Stage)	2.1
Maximum diameter (m)	1.45	1.45	(included in First Stage)	1.45
Gross lift off weight (kg)	commercially confidential			
Payload weight (kg)	≤180			
Dry mass (kg)	commercially confidential	commercially confidential	(included in First Stage)	commercially confidential
Indicative materials present	Carbon Fibre-Reinforced Plastic (CFRP) Aluminium Titanium Metal alloys Stainless steel Copper Polymers/plastics Batteries (4)	CFRP Aluminium Titanium Metal alloys Stainless steel Copper Polymers/plastics Batteries (2)	Carbon fibre	Carbon fibre Cork
Propellant and other gases	Liquid Petroleum Gas (LPG) LOX (liquid oxygen) Gaseous helium	Liquid Petroleum Gas (LPG) LOX (liquid oxygen) Gaseous helium	N/A	N/A
Approximate amount of propellant left upon re-entry (kg)	commercially confidential	commercially confidential	N/A	N/A
Likely fate	Exact separation heights will vary for each campaign. The worst-case scenario used as the basis for this AEE, assumes that the Orbex PRIME Launch Vehicle components do not fragment and burn up on re-entry, but instead enter the marine environment.			
Environmental Zone of Influence	See section below.			

Environmental Zones of Influence

10.8.8 Drawing 10.1 and Drawing 10.2 present the Northeast Atlantic and South Pacific EZIs respectively. These have been based on example trajectories provided by the Applicant in relation to the Orbex PRIME Launch Vehicle. The first stage, interstage and fairings are anticipated to return within the North Atlantic EZI, with the second (orbital) stage having the potential to return within the South Pacific EZI (if it does not burn up on re-entry). The South Pacific EZI (Drawing 10.2) may overlap with the EEZs of several countries, however the second stage will not be de-orbited on any trajectory where it will fall within the EEZs of any of these nations, unless prior permission is obtained.

10.8.9 The flight termination system (FTS) is non-explosive; instead cutting off power and thrust and resulting in the Orbex PRIME Launch Vehicle decelerating and returning to earth. The FTS is controlled by the range control officer who will terminate the launch if the Orbex PRIME Launch Vehicle experiences anomalies. The FTS tracks the predicted impact points in real time, and terminates thrust if activated, resulting in the Orbex PRIME Launch Vehicle continuing on a ballistic trajectory until it reaches the earth surface.

Sub-orbital Launches

10.8.10 As well as orbital launches, the Applicant is proposing to launch Orbex PRIME Launch Vehicles on a sub-orbital trajectory from SaxaVord Space Port.

Sub-orbital Launch Impact Dispersion Area

10.8.11 Sub-orbital launches will take place along a northerly azimuth (089.50˚ from the equator) from the launch site and will only be allowed to occur when meteorological conditions are such that no southerly movement of the Orbex PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences.

10.8.12 The impact dispersion area for sub-orbital launches will be significantly smaller than that of orbital launches, with an estimated ground track flight distance of 155 km from Launch Pad 3 for the first stage, fairing, and second stage, which will remain intact.

10.9 Standard Mitigation

10.9.1 The Federal Aviation Administration (FAA) methodology is applied to define an exclusion zone, which will apply to sea and air. Using FAA defined exclusion zones ensures a precautionary approach. The direction from land will vary with the launch azimuth, with bearings currently projected to range from 085 – 100 degrees from the equator. The exclusion zone will fan between the aforementioned bearings and will extend outwards from SaxaVord Spaceport as described in Chapter 3. Once an exclusion zone is identified, the area will be registered on Marine Charts and activated via a Notice to Mariners.

10.9.2 An exclusion zone is not anticipated to be required for the stages and fairings. For these, a Notice to Mariners will be published, with the exact areas dependent upon individual launches.

10.10 Potential Effects

10.10.1 A series of effect pathways on the marine environment have been identified as a result of the return of Orbex PRIME Launch Vehicles to Earth. Table 10.7 summarises the effect pathways to be considered for the Proposed Project.

10.10.2 The effects of direct strike on vessels have been screened out. There is no pathway for effect due to the standard operating procedure of implementing a Notice to Mariners and an exclusion zone around the Orbex PRIME Launch Vehicle.

Table 10.7 Impacts considered for the impact assessment of launches.

Key: ✓ = Impact present; ✗ = Impact not present

Impact	Launches
Effects on Water, and Sediment Quality, and Ecological Receptors from Fuel Spillage	✓
Effects on Water, and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination	✓
Effects on Water, and Sediment Quality, and Ecological Receptors from Debris and Microplastics (Including Ingestion)	✓
Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed	✓
Direct Strike	✓
Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface	✓
Thermal Effects of Jettisoned Objects	✗
Visual Disturbance	✗
Displacement of Fish	✓
Damage to Human Infrastructure (Subsea Cables/Pipelines)	✓
Interference with Military Exercise Areas	✓
Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic	✓
Damage to Marine Archaeology/Shipwrecks	✓
Interference with Marine and Coastal Tourism Activities/Industry	✗

10.10.3 The risk assessment matrices that correspond to the written description of the environmental effects in the sections below are provided in:

- Appendix 10.3 – water quality risk matrix;
- Appendix 10.4 – biodiversity risk matrix; and
- Appendix 10.5 –human activity risk matrix.

Effects on Water and Sediment Quality and Ecological Receptors from Fuel Spillage

10.10.4 It has been assumed that the worst-case scenario of total residual propellant upon re-entry will be approximately 100 kg.

10.10.5 The propellant for the first and second stages will comprise of Liquid Petroleum Gas (LPG), with Liquid Oxygen (LOX) as the oxidiser.

10.10.6 It is anticipated that any residual propellant in the returning stages will be expelled upon impact on the sea surface. Due to the nature of propane-like fuels, only the very surface of the water column is anticipated to be within the zone of effect from propellant release. Propane (in liquid form) is anticipated to dissolve in the water column and therefore remain at the sea surface, albeit over a small area and over a short timescale of a few days (Bravo-Linares *et al.*, 2021). However, as the liquid propane is pressurised, it is likely to become gaseous on release from the Orbex PRIME Launch Vehicle and enter the atmosphere after passing through the water column, thereby further reducing the potential for impact with the marine environment. The marine biodiversity receptors that have the potential to be in this zone of effect for a non-negligible period of time are plankton.

10.10.7 It is possible that aquatic organisms (i.e., plankton) that come into direct contact with naturally dispersed and entrained propellant will be killed (NOAA, 2019). However, given that the LPG will likely volatilise, the small area of effect and the abundance and turnover of plankton, this is not anticipated to cause significant changes to the marine community.

10.10.8 It is noted that fish kills are unlikely to occur as a result of LPG spills in the open ocean due to volatilisation and therefore concentrations are below lethal effects (NOAA, 2019). This is expected to be applicable to other marine megafauna too.

10.10.9 The water quality and biodiversity of the North Atlantic EZI has an important environmental value. The biodiversity receptor which may be impacted by hydrocarbons, plankton, may experience lethal effects as a result of exposure to hydrocarbons. Given this and the abundance and turnover of plankton, the sensitivity of these receptors is considered moderate.

10.10.10 Water quality and biodiversity receptors may be exposed to the effects of contaminants over an extensive period of time i.e., the full duration of the licence. Within the licence timeframe, launches are anticipated to occur up to a maximum of 10 times per year. It is noted that, due to the large spatial extent over which the Orbex PRIME Launch Vehicle components could return, it is extremely unlikely that the receptors will be exposed more than once, further reducing the frequency at which they could be exposed to hydrocarbon spills. The zone of effect of hydrocarbon spills is anticipated to be spatially limited to the immediate vicinity (<0.5 km^2) of the Orbex PRIME Launch Vehicle stages. Therefore, overall exposure of the receptors to the effect is low.

10.10.11 Direct effects on the hydrocarbon concentration of the sea water is likely to be measurable above natural variability, as there are limited other sources of hydrocarbons in the marine environment. Similarly, potential impact to the water quality is likely to be measurable above the baseline in that the hydrocarbon concentration will be elevated. However, only a small percentage change above the baseline or natural variation is predicted due to the small amount and rapid evaporation/dispersion of LPG in the marine environment. The magnitude of the impact is therefore low.

10.10.12 Moderate sensitivity, combined with low exposure and low magnitude, means that the risk to these receptors is low, which is equivalent to minor risk. No likely significant effect.

Effects on Water and Sediment Quality and Ecological Receptors from Metal Corrosion and Toxic Contamination

10.10.13 Several types of metal are present in the Orbex PRIME Launch Vehicle. The marine environment of the North Atlantic EZI is therefore described in terms of these specific metals.

10.10.14 Lithium (Li) in the open ocean is present in low concentrations in seawater (typically 1 ppm) (SAMCO, 2018). The main input of lithium to the ocean is weathering of continental crust, though there has been a reported increase in anthropogenic inputs near populated areas (e.g., Choi et al., 2019). Lithium is a non-essential nutrient to marine biota (Campbell et al., 2005). Campbell et al. (2005) reported that, for Arctic waters, lithium is present in high concentrations in zooplankton as a result of bioconcentration from seawater. The concentration in seals, fish, and birds was several orders of magnitude lower than in plankton, which indicates that lithium decreases trophically through the food web (Campbell et al., 2005). Lithium therefore only has the potential to affect the zooplankton and such lower levels in the food chain. Given that only a small proportion of the food web (zooplankton) has the potential to be affected, and that zooplankton are abundant and have high turnover, the effects are expected to be negligible.

10.10.15 Aluminium (Al) is one of the most resistant metals to corrosion in the marine environment and so is used widely in the shipping industry (Almet-Marine, 2020). The primary natural input of aluminium to the marine environment is from aeolian sources, though this input is limited in Arctic waters. Here, aluminium is low in surface waters and increases with depth (Wong *et al*., 1983). Aluminium is present in seawater in trace levels, ranging from 5-20 nmol/L, and is non-essential to marine life (Wong *et al*., 1983; Gilmore, 2014). The low number of studies on species' sensitivity to aluminium has shown there is great interspecies variability (Gilmore, 2014). So far, it has been reported that species of urchin, coral and macroalgae are tolerant, whereas some species of molluscs and phytoplankton show toxicity responses to lower concentrations of aluminium (Gilmore, 2014). The potential effects of elevated aluminium on marine life are therefore highly variable and species-specific. Nevertheless, it is unlikely that the introduction of aluminium as a result of the presence of the Orbex PRIME Launch Vehicle components would increase aluminium concentration to levels where a toxic effect occurred, except in the immediate vicinity of the Orbex PRIME Launch Vehicle component.

10.10.16 Stainless steel is one of the most resistant metals to corrosion in the marine environment and thus is used widely by numerous marine industry sectors (Davis, 2020). Stainless steel derives its resistant properties via the formation of a protective chromium oxide skin on the surface of the metal, protecting the base metal (and importantly the iron present). This prevents exposure to moisture, mitigating the formation of iron oxide or rust (Thyssenkrup, 2022). In addition, the inclusion of molybdenum in stainless steel helps to stop the saltwater causing pitting or crevice corrosion. As an alloy metal, stainless steel is not naturally present in the marine environment. However, many anthropogenic structures and vessels present within the Arctic circle use steel and stainless steel, such as oil and gas platforms. Iron (the base metal of stainless steel) occurs naturally in the marine environment, but generally in very low concentrations (being at its lowest in surface waters and increasing with depth) (Wong *et al*., 1983; Street and Payton, 2005). Iron is used primarily by phytoplankton in the marine environment, as it is required for the synthesis of chlorophyll and for the reduction of CO_2, SO_4(2-), and NO_3(-) during the photosynthetic production of organic compounds (Street and Paytan, 2005). Considering the low corrosion potential of stainless steel, and the fact that it is not considered a toxic metal for marine species (no great sensitivity is known) (UKMSACP, 1995) and factoring the small amounts of material composing the Orbex PRIME Launch Vehicle, then the effects of introducing stainless steel into the environment are expected to be negligible.

10.10.17 Copper (Cu) is present in the marine environment naturally and via anthropogenic sources at a mean concentration of 145 ng/kg (ppt) (Rauch and Graedel, 2007), however this varies greatly by region, and is elevated in coastal areas influenced by anthropogenic activities (Leal *et al*., 2018). In the Atlantic Ocean, copper (Cu) concentration increases with depth and latitude (Pohl *et al*., 1993). Copper concentration is higher near the shelf due to dissolution from shelf sediments and higher inputs from freshwater sources (Pohl *et al*., 1993). There is no interannual variation in copper levels in the Atlantic Ocean (Pohl *et al*., 1993). The input of copper into the marine environment has increased four-fold since the start of the industrial era (Lopez *et al*., 2019). Most copper is deposited through the atmosphere into the surface layer (Lopez *et al*., 2019). Of the total copper that is inputted to the surface layers, only a fraction is soluble and so able to be used by marine life (Lopez *et al*., 2019). Copper is an essential nutrient in the marine environment (Stern, 2010); hence it is typically present in high concentrations in all marine life across all trophic levels and does not bioaccumulate (Campbell *et al*., 2005). Many organisms produce organic ligands that bind copper to reduce its free ionic form (Cu^{2+}) and reduce its toxicity (Sueur *et al*., 1982; Gledhill *et al*., 1999). At high concentrations in seawater copper can be toxic to phytoplankton, though this is typically in areas subject to heavy anthropogenic emissions (Lopez *et al*., 2019). It is unlikely that the copper concentrations in the North Atlantic EZI are sufficiently high as to be toxic, as it is away from major coastal anthropogenic inputs. Copper alloys also present in the Orbex PRIME Launch Vehicle (e.g. brass and bronze), are similarly unlikely to result in significant impacts to marine life (Sclodnick *et al*., 2020) and have no added toxicity above that of the pure metals (Earley *et al*., 2020). With several years of degradation these metals may act as a substrate for marine life (MacLeod, 1982). As copper in the North Atlantic EZI is not predicted to be present in toxic levels, and is an essential nutrient, a small, localised increase in copper concentrations in seawater is not likely to be detrimental to marine life.

10.10.18 Titanium is found naturally in sea water, at extremely low concentrations, in the form of an oxide (Lide, 2004). Dissolved titanium is depleted at the ocean surface and enriched in deeper waters by an order of magnitude. The dominant form of dissolved titanium in sea water is that of $TiO(OH)_2$, which has a short particle-reactive oceanic residence time, and is also present in ferro-manganese nodules (Orians et al., 1990).

Titanium nanoparticles have been shown to have adverse effects in some species of algae, fish, and phytoplankton (Galletti *et al*., 2016), however are relatively inert at larger sizes (Sahoo *et al*., 2019). A recent baseline study of titanium in marine mammal tissues found levels to be generally low, with a global mean level equal to 4.5 +/0 0.25 µg/g (Wise *et al*., 2011). Dissolved titanium is potentially analogous to aluminium, which is more strongly studied, and discussed above. The magnitude of impact is predicted to be low and highly localised.

10.10.19 The water quality and biodiversity of the North Atlantic EZI has an important environmental value, with certain biodiversity features also having an important cultural value. The most sensitive receptor is expected to be slightly tolerant and adaptable to increase in the contaminant levels. The source of contaminants (components of the Orbex PRIME Launch Vehicles) will pass through the water column and then rest on the seabed. Biodiversity receptors will be exposed to increased contaminants as the Orbex PRIME Launch Vehicle component passes through the area of the water column that they occupy. Water quality will be affected throughout the passage of the component. Given the predicted small increase in concentration of contaminants, it is anticipated that biodiversity and water quality receptors will be able to recover within short timescales (<1 year). The sensitivity of these receptors is therefore low.

10.10.20 Water quality and biodiversity receptors may be exposed to the effects of contaminants over an extensive period of time i.e., the full duration of the licence. Within the licence timeframe, launches are anticipated to occur up to a maximum of 10 times per year. It is noted that, due to the large spatial extent over which the Orbex PRIME Launch Vehicle components could return, it is extremely unlikely that the receptors will be exposed more than once, further reducing the frequency at which they could be exposed. The zone of effect of contaminants is anticipated to be highly spatially limited to the immediate vicinity (i.e., metres) of the Orbex PRIME Launch Vehicle components. Therefore, overall exposure of the receptors to the effect is low.

10.10.21 Any impact is likely to be small and slightly above the range of natural variation in the marine environment. This is suitably precautionary as little is known about the fine-scale variation of contaminant concentration in the marine environment of the North Atlantic EZI. Potential effects on the water quality are expected to be measurable above the present baseline, though for biodiversity it is anticipated that potential effects will not affect the baseline. The magnitude of the impact is therefore low.

10.10.22 Low sensitivity, combined with low exposure and low magnitude, means that the risk to these receptors is low, which is equivalent to minor risk. No likely significant effect.

Effects on Water and Sediment Quality and Ecological Receptors from Debris and Microplastics (Including Ingestion)

10.10.23 There is the potential for plastic to enter the marine environment as plastic is used for liners of the propellant tanks. Plastic may be present in Stages 1 and 2.

10.10.24 The plastic classes present in the Orbex PRIME Launch Vehicle are epoxy resin (in the carbon fibre composites), and small quantities (<5 kg) of polytetrafluoroethylene (PTFE). These plastics are commonly used in the aerospace industry and in harsh environments, due to their durability when exposed to extreme temperatures or harsh chemicals. As a result, they maintain structural integrity in marine environments and have the potential to accumulate over time. The likely degradation process for PTFE in the marine environment is data deficient, however another common thermoplastic polymer, High-Density Polyethylene (HDPE), has been discussed below as an example.

10.10.25 HDPE is already present in the baseline of the marine environment as it is a type of plastic commonly found in marine litter, specifically plastic milk and juice jugs (Andrady, 2011). HDPE has been reported in the Arctic and given that the Arctic is a hotspot for plastics, it is likely that HDPE is already present in notable concentrations in the North Atlantic EZI (Obbard *et al*., 2014). HDPE has a specific gravity of 0.94, less than the 1.025 of seawater, indicating that it floats in the marine environment (Andrady, 2011). The average specific surface degradation rate for HDPE in the marine environment is 4.3 μm/year (Chamas *et al*., 2020). HDPE in the marine environment has an estimated half-life of 58 years, shorter than in landfill/compost/soil conditions (250 years) (Chamas *et al*., 2020). It is anticipated that any plastic present in the returning components would be large (>5 mm) and so classified as macroplastics at the point of entry (NOAA, 2020a), but would breakdown over a period of time during which microplastics (<5 mm) would be emitted.

10.10.26 Microplastics are readily ingested by marine organisms either through direct ingestion or indirectly by trophic transfer from contaminated prey (Nelms *et al*., 2018). These can have accumulation and ecotoxicological effects, both directly on primary consumers, and indirectly through trophic transfer (Anbumani and Kakkar, 2018; Botterell *et al*., 2019; Prokić *et al*., 2019). There are records of microplastic polyethylene ingestion in a range of holoplankton and meroplankton, including ichthyoplankton, though the recorded taxa are likely an underestimation due to the frequency of not reporting plastic class (Botterell *et al*., 2019). As summarised by the review of Nelms *et al*. (2018), there has been many inferences of trophic transfer of microplastics due to the recorded presence of microplastics in the faeces and stomach contents of species groups at higher trophic levels including fish, birds, and marine mammals.

10.10.27 Studies on the biological effects of microplastics in the field are rare (Botterell *et al*., 2019). In smaller organisms, microplastic ingestion has been shown to cause detrimental physiological impacts such as reducing feeding capacity, energy reserves, and reproductive output (Nelms *et al*., 2018). The effects on higher marine organisms are not well known. A few studies have shown that microplastics can be excreted after some days in the stomach, indicating a lower likelihood of the more severe physiological effects seen in small organisms (Nelms *et al*., 2018).

10.10.28 Debris, which will primarily comprise carbon composite, may also enter the environment. An example of the composite used by the Orbex PRIME vehicle is carbon fibre-reinforced polymers (CFRP), which are carbon polymers bound within an epoxy thermoset resin. There are few studies on how such composite material might break down in the marine environment, and in turn how the subsequent contaminants present may affect marine life. One study on Japanese rice fish (*Oryzias latipes*) found no toxicity associated with carbon fibres under semi-static conditions, where water was in flux (Ueda *et al*., 2020). When returning to earth, the stages and fairing will hit the ocean at high velocity and therefore incur mechanical damage upon impact. The carbon composite is likely to sink upon entry into the marine environment, as has been recorded for other returning stages. The Orbex PRIME Launch Vehicle components are designed to withstand the extreme conditions of launch and travel; therefore, it is considered likely that any corrosion will be limited and only occur over long timeframes. To illustrate, the thrust chamber of one of the first stage F-1 rocket engines to launch the Saturn V rocket over 50 years ago has been recently detected on the seafloor, intact, and has been recovered (Space.com, 2013) (noting that these were made from aluminium and not a composite structure). The worst-case scenario, of a limited amount of corrosion of the composite material, may result in an increase in various contaminants in the marine environment, however due to the large quantity available for dilution of relatively small parts, toxic concentrations are not likely to occur.

10.10.29 The water quality and biodiversity of the North Atlantic EZI has an important environmental value, with certain biodiversity features also having an important cultural value. The most sensitive receptor, plankton, is expected to be slightly tolerant to low levels of microplastic ingestion which could potentially occur as a result of plastic from the Orbex PRIME Launch Vehicle entering the marine environment. As a result of this potential ingestion and subsequent change plankton could be noticeably affected. The source of microplastics (plastic liners) will be of unknown size upon entering the marine environment, though it is hypothesized that they will enter as macroplastics encased within, or bonded to, the relevant stage and will sink through the water column to rest on the seabed. The quantities of plastic within the stages are not predicted to inhibit its sinking to the seabed. Biodiversity and water quality receptors will be exposed to increased microplastics as the Orbex PRIME Launch Vehicle components break down on passage through the area of the water column that they occupy. Given the predicted small increase in concentration of microplastics, the high turnover and abundance of the most sensitive receptor (plankton), and the potentially short residence time in the gut of larger marine organisms, it is anticipated that biodiversity and water quality receptors will be able to recover within short timescales (<1 year). The sensitivity of these receptors is therefore moderate.

10.10.30 Water quality and biodiversity receptors may be exposed to the effects of microplastic over an extensive period of time i.e., the full duration of the licence. Within the licence timeframe, launches are anticipated to occur up to a maximum of 10 times per year. It is noted the large spatial extent of the North Atlantic EZI will act to reduce the likelihood of exposure to any individual. The zone of effect of microplastics is anticipated to be spatially limited, with concentrations of microplastics decreasing to below effect levels outside of the immediate vicinity of the Orbex PRIME Launch Vehicle components. Therefore, overall exposure of the receptors to the effect is low.

10.10.31 Any increase in microplastics is likely to be small and slightly above the range of natural variation in the marine environment. This is suitably precautionary as there is minimal information on natural variation, though background levels are predicted to be high in the Arctic waters that overlap the North Atlantic EZI. The impact on water quality is expected to be measurable above the present baseline, at a local scale, though for biodiversity it is anticipated that potential impacts will not affect the baseline. The magnitude of the impact is therefore low.

10.10.32 Moderate sensitivity, combined with moderate exposure and low magnitude, means that the risk to these receptors is low, which is equivalent to minor risk. No likely significant effect.

10.10.33 It is noted that there are elements of uncertainty in the overall impact assessment of debris and microplastics, particularly with regards to the assessment envelope. However, the conclusion of the assessment concurs with the conclusion of the Draft Environmental Impact Statement for the Mars 2020 Mission (NASA, 2020) for impact of contaminants on the local marine environment, which assessed significantly larger launch vehicles than the Proposed Project.

Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed

10.10.34 The North Atlantic EZI is poorly understood in terms of its benthic habitats, as described in Appendix 10.1. It is likely that the most species rich group is arthropods, followed by polychaetes and molluscs (Figure A10.3). Within the South Pacific EZI, urchins, holothurians, and sponges are also common. Vulnerable Marine Ecosystems (VMEs) are also present in the EZI (Figure A10.4; Drawing 10.3). VMEs are sensitive to benthic pressures, though protection measures from these pressures are only applicable where they arise from fishing. There are a few Marine Protected Areas (MPAs) in the region that have designated benthic habitat features, therefore, the benthic habitats receptor is considered to have a high value.

10.10.35 The landing of the components at the seabed may directly impact benthic habitats in the North Atlantic EZI. If the component lands in/on a sensitive benthic habitat, it would likely be intolerant of the change and unable to adapt, with potentially lethal or destructive effects It is anticipated that following impact, the Orbex PRIME Launch Vehicle first stage will likely remain at the water surface for a number of hours before sinking (maximum 12 hours; 1-2 hours probable time frame).

10.10.36 Studies of surface water circulation in the Norwegian basin using Lagrangian drifters indicate that typical horizontal drift is not predicted to exceed 10 km in 24 hrs (Poulain *et al*., 1996; Jakobsen *et al*., 2003). Eddies further contribute to constraining the region. Therefore, it is not likely that debris will drift outside of the predicted greater impact area before (or after) sinking. Due to the extremely large spatial extent of the Pacific EZI, it is not possible to accurately predict the currents in one area due to unknowns in trajectory and ocean state at the time of launch. However, as the second stage is smaller than the first stage and made of similar materials, impacts are predicted to be similar but of lesser magnitude.

10.10.37 After sinking through the water column, any component is predicted to come to rest at a single place at the seabed, only impacting the habitat directly within the footprint (maximum of 13.7 m by 1.45 m, with a volume of ~22.6 m^3). The footprint of the impact is likely to be smaller than the full extent of the benthic habitat in a given area. Therefore, it is likely that once the component has fully broken down, the surrounding benthic habitat will enable the impacted zone to be recolonised, though this can only happen over a long timescale.

10.10.38 There is also the possibility that the novel infrastructure surface could be colonised whilst intact on the seabed i.e., act like an artificial reef, though this is not confirmed. The introduction of artificial habitats into an environment are known to have a number of impacts on the local environment. The addition of hard substrate may allow for the colonisation of species that would otherwise be unable to exist in the local environment. Fish aggregating device effects may also result from the addition of hard substrate within the environment, causing a localised increase in species richness and abundance, and potentially decreasing these measures in the surrounding area. Further, increased biological activity surrounding the debris may result in an increased level of local nutrient levels through increased deposition flow of organic material. All of these effects are however likely to be confined to the close vicinity of any debris. Over the next 30 years it is anticipated that up to 10 launches will take place per year (totalling 300 launches), resulting in a potential total debris volume of approximately 10,110 m^3 for all stages and fairings combined. Debris from second stage components, would make up to a total dry mass of 525 kg maximum. When compared to the total volume of the North Atlantic EZI, this potential reef volume is likely to have a negligible impact on the marine environment. It is also likely that larger bits of debris will break up with time, further reducing the total volume of potential reef. In conclusion, the most sensitive benthic habitats have a low tolerance or adaptability, though the habitat may recover on a long timescale.

10.10.39 Due to the high value, low tolerance, adaptability, and recoverability, benthic habitats are considered to have high sensitivity to direct loss of seabed habitat via deposition of material on the seabed.

10.10.40 The Proposed Project will have a maximum plan of up to 10 launches per year. Although the licence term is considered to have high longevity, the likelihood of Orbex PRIME Launch Vehicle components impacting the same area of benthic habitat is extremely low, considering the total extent over which the Orbex PRIME Launch Vehicle components could enter the marine environment. Therefore, the longevity of the impact has been reduced to low to reflect this short time period per impact.

10.10.41 As evidenced by Figure A10.4 and Drawing 10.3, VMEs (Vulnerable Marine Ecosystems) are numerous in the North Atlantic EZI, particularly around the coasts of landmasses. There are only a few MPAs with benthic features, though these are typically large in extent. There are multiple large MPAs within the Pacific EZI, however the second stage will not be released on any trajectory where it could land in one of these areas. The impact zone around the Orbex PRIME Launch Vehicle stages/fairing are extremely small in comparison to the areas of sensitive and/or protected benthic habitats. Therefore, the spatial extent of the impact is low.

10.10.42 An overall low longevity and spatial extent result in a low exposure of benthic habitats to direct loss caused by the returning component.

10.10.43 Any potential impact to benthic habitats is likely to result in a small measurable change to the baseline in the immediate vicinity of the component. This change is likely to be measurable above natural variability, as sensitive benthic habitats such as VMEs are long-lived and there are few other sources of direct loss. Therefore, the magnitude of impact in terms of baseline and natural variability is low.

10.10.44 High sensitivity, combined with low exposure and low magnitude, mean that the risk to benthic habitats from direct loss caused by the returning Orbex PRIME Launch Vehicle component is minor. No likely significant effect.

Direct Strike

10.10.45 Marine ecological receptors that have the potential to be present at, above, or just below the sea surface, concurrent with a returning Orbex PRIME Launch Vehicle component, include seabirds and marine megafauna. Many species of these ecological receptor groups are protected under various nature conservation legislation and constitute and essential part of the ecosystem. Accordingly, the receptors that may be affected by this impact pathway have been ascribed a high value.

10.10.46 The maximum i.e., worst-case mass of any returning Orbex PRIME Launch Vehicle stage is not anticipated to exceed approximately 1,275.5 kg (dry mass of first stage plus residual fuel). The returning components will be travelling at considerable speed at the point of entry into the marine environment. The return speed is expected to be 60 m/s for the first stage, 30 m/s for the fairing, and 60 m/s for the second stage (in the case of sub-orbital launches, where second stage impacts are predicted).

10.10.47 The return of the Orbex PRIME Launch Vehicle components through the Earth's atmosphere and into the marine environment has potential to cause injury and/or death to marine ecological receptors which are in the return flightpath. A component may collide with species that spend time at, above, or just below, the sea's surface.

10.10.48 The ecological receptors and their specific behaviours which may lead to them being affected by a returning Orbex PRIME Launch Vehicle component include:

- Foraging or migrating seabird species, which may be flying above the water;
- Foraging or loafing seabird species, which may be floating on the water surface;
- Pinniped species, which may be at or just below the water surface;
- Cetacean species, which may be at or just below the water surface;
- Basking shark (*Cetorhinus maximus*), whale shark (*Rhincodon typus*), and oceanic sunfish (*Mola mola*), which may be at or just below the water surface; and
- Designated seabird features of MPAs, behaving as described above.

10.10.49 Given the size of the components and the speed at which they are predicted to return, it is anticipated that any receptors struck by the returning component would experience mortality. Larger animals such as baleen whales may experience serious physical injury if not directly struck, however this is also considered likely to lead to mortality, albeit indirectly. Individual marine ecological receptors are not tolerant, adaptable, or able to recover from mortality events.

10.10.50 A high ecological and cultural value, combined with no tolerance, adaptability, and recoverability, results in the aforementioned ecological receptors having a high sensitivity to direct strike from returning Orbex PRIME Launch Vehicle components within the North Atlantic EZI.

10.10.51 The Proposed Project will have a maximum plan of up to 10 launches per year, therefore the longevity of the potential impact is high. The frequency of the impact is low at a maximum of two launches per month. This is further reduced when it is considered that a single individual is only likely to exposed to this impact up to once in a lifetime. The returning Orbex PRIME Launch Vehicle component will only impact the area directly where it lands, which, compared to the total available habitat within the North Atlantic EZI (including the entire water column below the surface layers and total air space for flying birds), is low.

10.10.52 A low frequency and spatial extent, combined with a high longevity, result in a low exposure of ecological receptors to direct strike from the returning component.

10.10.53 The likelihood of such an impact occurring is considered to be very low. Should it occur, it is expected that only single individuals would be affected. Collisions between these ecological receptor groups and vessels (in water) or anthropogenic infrastructure (in air) is not an uncommon occurrence. Similarly, the natural level of mortality in these species would mean that the additional mortality of a limited number of individuals would not affect the population baseline nor be detectable above the natural variability of populations which fluctuates on a range of timescales. Therefore, the magnitude of effect is negligible.

10.10.54 A high sensitivity, combined with a low exposure, and negligible magnitude, mean that the risk to ecological receptor populations (seabirds, marine megafauna, and MPAs) in the North Atlantic EZI from direct strike by the returning Orbex PRIME Launch Vehicle component is negligible. No likely significant effect.

Acoustic disturbance (including underwater noise) from the impact of the jettisoned objects hitting the sea surface

10.10.55 The occurrence of excessive noise input into the ocean can elicit a range of responses in marine ecological receptors, such as mortality, physiological injury, auditory injury (either permanent or temporary), disturbance, and masking. The magnitude of the response is dependent on the properties of the sound source, such as the loudness, frequency, and duration, as well as the state of the receiving individual. The marine ecological receptor groups with demonstrated sensitivity to noise include plankton, fish, and marine megafauna. Benthic habitats are also known to be sensitive to noise but given the probable water depths at the point of Orbex PRIME Launch Vehicle component return, it is unlikely that the received noise at the seabed will be above the threshold to cause a response. Seabirds have limited sensitivity to underwater noise and are also highly unlikely to be present in the water in the immediate vicinity of the Orbex PRIME Launch Vehicle component when the noise occurs, therefore these are not considered further.

10.10.56 The characteristics of the acoustic emission produced by the Orbex PRIME Launch Vehicle component hitting the water is not known. Taking into consideration the speed at which the largest individual component will be travelling (estimated first stage impact speed 60 m/s), the maximum size (first stage: 13.7 m × 1.45 m), and the weight (~1,223 kg), it is likely that the sound will comprise a single pulse, of high intensity and short duration (impulsive). These acoustic properties are similar to the sound produced by explosive detonation in the marine environment. As considerably more is known about the sound emissions of explosives, this source has been used a proxy for the sound emitted by returning Orbex PRIME Launch Vehicle components in this assessment.

10.10.57 Explosive noise is characterised as broadband i.e., occurs across a wide frequency range, with a peak energy content in the low frequency bands of 63-500 Hz (Paro *et al*., 2015). It has a high peak sound pressure level that can exceed 200 dB re 1μPa at distances around 200-300 m distance from the source (Paro *et al*., 2015).

10.10.58 Due to the high intensity of the noise, it is possible that marine receptors in the immediate vicinity (i.e., metres) of the impact would experience physiological trauma and therefore experience a mortality effect. At increased distances, the severity of the response will decrease.

10.10.59 As explosive noise is broadband, with peak content in the low frequency band, it falls within the hearing range of many marine ecological receptor groups. All fish species have a hearing range that overlaps this low frequency band, including hearing specialists (such as Pacific herring) and hearing generalists (such as basking sharks). All marine mammal hearing groups, including low-, mid- and high- frequency cetaceans, and pinnipeds in water, would be able to detect the noise produced as it falls within the lower end of their hearing range (NOAA, 2018). Zooplankton have been shown to be sensitive to low frequency underwater noise from seismic sources which produce sound in a similar frequency range to explosions (McCauley *et al*., 2017).

10.10.60 The potential impact ranges for the different receptors are as follows. The assessment of impact ranges has been based on an environmental assessment of drilling and blasting by National Grid (2018). In this assessment, the maximum injury ranges were as follows: 104 m for low-frequency cetaceans; 43 m for mid-frequency cetaceans; 171 m for high-frequency cetaceans; 65 m for phocid pinnipeds; and 14 m for fish. The maximum disturbance ranges were: 139 m for low-frequency cetaceans; 57 m for mid-frequency cetaceans; 227 m for high-frequency cetaceans; and 87 m for phocid pinnipeds (fish were not assessed for disturbance). With regards to zooplankton, McCauley *et al*. (2017) reported that, for seismic airguns, impacts were reported out to the maximum 1.2 km sampled.

10.10.61 The Proposed Project will have a maximum of up to 10 launches per year, therefore the longevity of the potential impact is high. The frequency of the impact is low at up to maximum two launches per month. The returning Orbex PRIME Launch Vehicle components will create an impact zone with a radius of 10s of metres for seabirds, 14 m for fish, 277 m for marine mammals, 1.2 km for plankton. The spatial extent of these impact zones is low when compared to the total available habitat within the North Atlantic EZI for these marine ecological receptors.

10.10.62 A low frequency and spatial extent, combined with a high longevity, result in a moderate exposure of ecological receptors to direct strike from the returning component.

10.10.63 The likelihood of a severe disturbance impact occurring is considered to be very low. Should it occur, it is expected that only a low proportion of the population would be affected (in the region of <0.01%). The proportion of the population that could experience a minor disturbance effect could be an order of magnitude greater, as the impact zones for such effects are typically larger, but this would still be a small proportion in the context of the population. As such, it is considered that the impact of disturbance from the component returning would not affect the baseline nor be detectable above the natural variability. Therefore, the magnitude of effect is negligible.

10.10.64 A high sensitivity, combined with moderate exposure, and negligible magnitude, mean that the risk to ecological receptors (plankton, fish, marine megafauna, seabirds) in the North Atlantic EZI from disturbance by the returning components is negligible. No likely significant effect.

Thermal effects of jettisoned objects

10.10.65 While it is likely that the Orbex PRIME Launch Vehicle component will have associated thermal energy, any heating of the marine environment will be highly localised. Tidal and wind driven currents will allow for heated water to dissipate into the surrounding waters rapidly. It is highly unlikely that any marine receptors will be impacted as a result of these temporary heating events. Due to heating being highly localised and temporary, thermal effects are likely to have a footprint similar to those determined for Direct Strike effects. Thermal effects are therefore considered negligible. No likely significant effect.

Visual Disturbance

10.10.66 Once any Orbex PRIME Launch Vehicle component has impacted the surface of the marine environment, it will likely remain at the water surface for a short time before sinking through the water column (with the exception of materials with specific gravity lower than seawater). Whilst it is at the surface or in the water column there is the potential for visual disturbance to marine ecological receptors. The component will be stationary once in the water, moved only by the ocean movements. The size of any component will be a maximum of 13.7 m × 1.45 m, corresponding with the size of the first stage. In essence, it is anticipated to behave like a large item of marine litter and will therefore be difficult to predict in terms of sinking rate or likelihood of washing up on coastlines. For example, movements may be dependent on near-surface currents, surface current, wind, and wave action. This evidence gap should be addressed by independent research, that is outside of the scope of this assessment.

10.10.67 In general, fish species are not considered sensitive to visual disturbance (Natural England, 2017). Though basking shark has been observed to show visual disturbance from moving craft, they are unlikely to show a response to a stationary object (Natural England, 2017). Fish are therefore not considered sensitive to potential visual disturbance from the components in the water. Marine mammals have been observed showing behavioural response to non-motorised craft, which is almost certainly due to visual disturbance as opposed to noise disturbance (Natural England, 2017). However, the likelihood of a behavioural response occurring is variable. To illustrate, only half of common bottlenose dolphin encounters with kayaks in Cardigan Bay resulted in the dolphins moving away (Natural England, 2017). It is considered highly unlikely that the stationary presence of a Orbex PRIME Launch Vehicle component would cause any impacts, therefore marine mammals are also not considered further for visual disturbance.

10.10.68 Seabirds have been reported as showing visual disturbance to vessels whilst in air and also on water (Natural England, 2017). Similarly, certain species of seabird have been reported to avoid large anthropogenic structures in the marine environment such as wind farms, though these cover a much larger extent than the proposed components. The distance at which birds typically initiate a flight response and flush from an area as a result of visual disturbance is typically <40 m (Natural England, 2017). This disturbance distance is applicable to the scenario of the Orbex PRIME Launch Vehicle component floating towards seabirds loafing on the sea surface. The most sensitive seabirds have been assumed to show a visual disturbance effect up to 4 km from large marine infrastructure such as windfarms. As windfarms are several orders of magnitude larger than the size of Orbex PRIME Launch Vehicle components, with an associated high degree of visibility/sightlines above relative sea level, it is anticipated that the disturbance zone for the component would be several orders of magnitude smaller than this i.e., in the tens of metres.

10.10.69 The marine ecological receptor groups that have the potential to are either commercially, environmentally and/or culturally important and therefore for the purpose of this assessment have been ascribed a high value.

10.10.70 A high ecological and cultural value, combined with no tolerance, adaptability, and recoverability, results in the aforementioned ecological receptors having a high sensitivity to disturbance effects from returning components within the North Atlantic EZI.

10.10.71 A low frequency and spatial extent, combined with a high longevity, result in a moderate exposure of ecological receptors to direct strike from the returning component.

10.10.72 The likelihood of a severe disturbance impact occurring is considered to be very low. Should it occur, it is expected that only a low proportion of the population would be affected (in the region of <0.01%). The proportion of the population that could experience a minor disturbance effect could be an order of magnitude greater, as the impact zones for such effects are typically larger, but this would still be a small proportion in the context of the population. As such, it is considered that the impact of disturbance from the component returning would not affect the baseline nor be detectable above the natural variability. Therefore, the magnitude of effect is negligible.

10.10.73 A high sensitivity, combined with moderate exposure, and negligible magnitude, mean that the risk to ecological receptors (plankton, fish, marine megafauna, seabirds) in the North Atlantic EZI from disturbance by the returning Orbex PRIME Launch Vehicle components is negligible. No likely significant effect.

Displacement of Fish

10.10.74 The commercial fishing activity in the North Atlantic EZI is described in Appendix 10.2. The North Atlantic EZI comprises an important area for commercial fisheries from several different nations, with primarily benthopelagic and pelagic fish targeted. Figure A10.7 displays commercial fishing vessel activity, as recorded by AIS transmission, showing that most AIS datapoints are located in the southern portion of the North Atlantic EZI, with decreasing effort with distance north. As the fisheries industry in the North Atlantic EZI is valuable and culturally important to several countries, the receptor is considered to have a high value.

10.10.75 The landing of the components on the sea surface may indirectly impact commercial fisheries. If the component lands in a productive fishing ground, target fish species may be disturbed and displaced from the location, thus reducing the productivity of said fishing ground. Whilst displacement can be considered an adverse impact, it is possible that this impact will act as mitigation against the displacement of fishing vessels. If the landing of the component displaces target fish species from the impact zone, the abundance of fish in other fishing grounds may increase. As fish species are highly mobile, they have a high tolerance and adaptability to displacement.

10.10.76 Due to their mobility, and the short period of impact and low magnitude of disturbance, fish species will be able in return to the impact zone within a short timescale of the component passing through. Therefore, the recoverability of fish stocks is high.

10.10.77 Despite the high value, a high tolerance, adaptability, and recoverability result in fish stocks having a low sensitivity to displacement caused by the components entering the marine environment.

10.10.78 The Proposed Project will have a maximum of up to 10 launches per year. Therefore, the frequency of the impact is low at maximum up to two launches per month. Although the full licence term is considered to have high longevity, displacement to fishing stock is predicted to happen only on a short-term scale whilst the Orbex PRIME Launch Vehicle component is present in that specific area. Therefore, the longevity of the impact has been reduced to low to reflect this short time period per impact.

10.10.79 As evidenced by the AIS data (displayed in Figure A10.7), fishing grounds in the North Atlantic EZI are wide-spread and of high spatial extent. The impact zone around a component is extremely small in comparison to the fishing grounds. Therefore, the spatial extent of the impact is low.

10.10.80 A low frequency, longevity, and spatial extent result in a low exposure of fish stocks to displacement caused by the returning component.

10.10.81 Fish are highly mobile and often make use of a range of habitats and rarely remain in one specific location for extended periods. As the displacement caused by the returning components is of small spatial and temporal scale, the magnitude of impact in terms of baseline and natural variability is negligible.

10.10.82 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to fish stocks from displacement caused by the returning Orbex PRIME Launch Vehicle components is negligible. No likely significant effect.

Damage to Human Infrastructure (Subsea Cables/Pipelines)

10.10.83 As described in Appendix 10.1 there are several subsea cables and pipelines in the North Atlantic EZI, concentrated in the southern portion of the area. The subsea cables are operated by companies of several different nationalities and are of significant commercial and communications value to the countries where cable landfall is made. The oil and gas pipelines in the North Atlantic EZI supply nearby countries with hydrocarbons and so is also of significant value. Accordingly, subsea cables and pipelines in the North Atlantic EZI as a whole has been ascribed a high value.

10.10.84 The landing of the components at the seabed may directly impact subsea cables and pipelines in the North Atlantic EZI. If the component lands on such infrastructure, there is a possibility that the integrity of the cable or pipeline would be compromised, and significant structural damage could occur. The likelihood of this is reduced where such infrastructure is buried, however for the purpose of this assessment it is assumed that they are not buried. If a subsea cable or pipeline was compromised it would not be possible to tolerate, adapt, or recover from the impact (without anthropogenic intervention).

10.10.85 Due to the high value, and lack of tolerance, adaptability, and recoverability from the worst-case scenario effects, subsea cables and pipelines are considered to have high sensitivity to direct impact via deposition of material on the seabed.

10.10.86 The Proposed Project will have a maximum of up to 10 launches per year. Although the licence term has a high longevity, with a high associated number of launches, the likelihood of a Orbex PRIME Launch Vehicle component impacting the same subsea cable or pipeline is extremely low, considering the total extent over which the component could enter the marine environment. Therefore, the frequency of the impact has been reduced to low to reflect this.

10.10.87 Subsea cables and pipelines are restricted in their distribution in the North Atlantic EZI. It is anticipated that the maximum size of any single component that comes to rest on the seabed will be a maximum 13.7 m × 1.45 m, to which the footprint of the impact will be limited. The receptor will therefore be impact over a low spatial scale.

10.10.88 An overall low longevity and spatial extent result in a low exposure of benthic habitats to direct loss caused by the returning component.

10.10.89 There is no natural variation in subsea cables and pipelines as they are a constant presence on the seabed. Any potential impact to subsea cables or pipelines would cause a measurable change to the baseline, though this change would be temporary as it would require reparation. In addition, it is noted that, considering the small footprint of the impact, and the total area over which the Orbex PRIME Launch Vehicle components will return, the likelihood of the impact occurring is negligible. Therefore, the magnitude of impact is low.

10.10.90 High sensitivity, combined with low exposure and low magnitude, mean that the risk to subsea cables and pipelines from direct impact of returning Orbex PRIME Launch Vehicle components is minor. No likely significant effect.

Interference with Military Exercise Areas

10.10.91 As described Appendix 10.1, the North Atlantic EZI is utilised for military exercises by a variety of nations on an intermittent basis. Military activities are of significant financial and defence importance and therefore have been assigned a high value.

10.10.92 Any military activity that occurs in the North Atlantic EZI concurrently with the return of Orbex PRIME Launch Vehicle components has the potential to be affected. It is anticipated that, to ensure navigational safety, an exclusion zone will be implemented around the predicted landing position of the returning component. As the return to Earth of the components are monitored, communication with vessels operating nearby will be maintained to provide updates on the location and predicted impact zone of the components.

10.10.93 If the impact zone of a Orbex PRIME Launch Vehicle component is within an operational military exercise area, any vessels in the location would be temporarily displaced/excluded. Displacement or exclusion of military vessels whilst on transit could result in increased expenditure on fuel and sundries, and increased time for vessels to reach their destination due to having to take alternative routes/detours. Displacement of military vessels whilst on exercise would perhaps cause them to relocate the exercise, but this is unlikely to cause significant issues as the exercises are not location-specific (at the fine-scale of several kilometres). Therefore, with standard safety and communications in place, military activities are considered to have a high tolerance and adaptability to displacement, as military vessels are mobile and can easily adjust their course and positioning as required.

10.10.94 Once the Orbex PRIME Launch Vehicle and associated exclusion zone has passed, military vessels would be able to return to the area immediately. Therefore, military vessels have a high recoverability to displacement effects.

10.10.95 A high value, and high tolerance, adaptability, and recoverability, mean the sensitivity of military exercises within the North Atlantic EZI to displacement from returning components is low.

10.10.96 The Proposed Project will comprise a maximum of 10 launches per year. Although the licence term has a high longevity, with many associated launches, the exclusion zones will only be in place for the duration of the return of the Orbex PRIME Launch Vehicle, and therefore the longevity of the impact has been reduced to low to reflect this short time period per launch. Furthermore, to our knowledge, military exercises are not regular and only occur on an intermittent basis in the North Atlantic EZI and so the frequency of exposure is further reduced.

10.10.97 In order to be precautionary, it is assumed that components could return anywhere within the North Atlantic EZI. There is therefore the potential that the components could return in an area of military exercise. However, it is noted that such exercises are not spatially restricted in the North Atlantic EZI and indeed could occur over large areas. The small spatial extent of the exclusion zone, which will be limited to the immediate vicinity of the Orbex PRIME Launch Vehicle return, will therefore affect a small proportion of the total area that could be used by military activity. Therefore, the spatial extent of the impact is low.

10.10.98 A low frequency, high longevity, and low spatial extent result in a low exposure of military activity to displacement from returning components.

10.10.99 Vessels are mobile and are often required to relocate for a variety of reasons, including adverse weather and displacement from other vessels. As the displacement caused by returning components of small spatial and temporal scale, the magnitude of impact in terms of baseline and variability is negligible.

10.10.100 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to military activities from interference arising from is negligible. No likely significant effect.

Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic

10.10.101 As described in Appendix 10.1, shipping and commercial fishing activity within the North Atlantic EZI is relatively high. In particular, the southern portion of the North Atlantic EZI, which has considerable fishing effort (Figure A10.7) and is a main area of vessel traffic (Figure A10.5) and shipping density (Figure A10.6). Due to this level of activity, it is possible for returning components and the associated exclusion zone to have an impact on shipping and commercial fishing vessels. The high level of activity indicates the financial importance of the area to the surrounding countries; therefore, the value of the receptor is high.

10.10.102 It is anticipated that, to ensure navigational safety, an exclusion zone will be implemented around the predicted landing position of the returning component. At the time of writing, it is not expected that any components will be recovered. As the return of the component is monitored, communication with vessels operating nearby will be maintained to provide updates on the location and predicted impact zone of the component.

10.10.103 If the impact zone of an Orbex PRIME Launch Vehicle is within fishing grounds or along vessel transit routes, any vessels in the location would be temporarily displaced. Displacement of vessels or interruptions to transit routes can result in increased expenditure on fuel and increased time for vessels to reach their destination due to having to take alternative routes/detours. Displacement of fishing vessels from fishing grounds can result in loss of income as catch per unit effort is likely to be reduced if alternative productive fishing grounds cannot be exploited whilst the temporary exclusion zone is in place. The majority of the North Atlantic EZI is offshore therefore it is anticipated that most fishing vessels and shipping in the area will be large and so able to adapt their movements. Therefore, with standard safety and communications in place, shipping and commercial fishing activities have high tolerance and adaptability, as vessels are mobile and can easily react to adjust their course and positioning as required.

10.10.104 Once the Orbex PRIME Launch Vehicle component has entered the marine environment, exclusion zones can be removed and therefore transiting vessels and active fishing vessels can return to normal operation immediately. The recoverability is therefore considered high.

10.10.105 A high value, and high tolerance, adaptability, and recoverability, mean the sensitivity of shipping and commercial fishing activities within the North Atlantic EZI to displacement from returning components is low.

10.10.106 The Proposed Project will have a maximum of up to 10 launches per year. Although the licence term has a high longevity, with many associated launches, the exclusion zones will only be in place for the duration of the return of the Orbex PRIME Launch Vehicle, and therefore the longevity of the impact has been reduced to moderate to reflect this short time period per launch.

10.10.107 In order to be precautionary, it is assumed that components could return anywhere within the North Atlantic EZI and could be present on the water surface (floating), within the water column, or on the seabed. There is therefore the potential that the components could return in an area of high shipping density such as near the coast of a landmass, or in a key fishing area. However, it is noted that such areas of high fishing and shipping activity are widespread in the North Atlantic EZI. The small spatial extent of the exclusion zone, which will be limited to the immediate vicinity of the component return, will therefore affect a small proportion of the total area used highly by shipping and fishing vessels. Therefore, the spatial extent of the impact is low.

10.10.108 A low frequency, moderate longevity, and low spatial extent result in a low exposure of shipping and commercial fishing activity to displacement from returning components.

10.10.109 Vessels are mobile and are often required to take alternative routes or use other fishing grounds for a variety of reasons, including adverse weather and displacement from other vessels. As the displacement caused by returning Orbex PRIME Launch Vehicle components of small spatial and temporal scale, the magnitude of impact in terms of baseline and variability is negligible.

10.10.110 Low sensitivity, combined with low exposure and negligible magnitude, mean that the risk to shipping and commercial fishing activities from interference arising from launches is negligible. No likely significant effect.

Damage to Marine Archaeology/Shipwrecks

10.10.111 As described in Appendix 10.1, it has not been possible to determine the extent of the presence of marine archaeological features in most of the North Atlantic EZI. For the purpose of this assessment, however, it is assumed that marine archaeological features are present and so have the potential to be impacted by the proposed operations.

10.10.112 The value of marine archaeological features can vary depending on the feature type and level of preservation. As a worst-case scenario, it is assumed that any given marine archaeological feature in the North Atlantic EZI has a high value, due to its cultural and historical significance.

10.10.113 The landing of the components at the seabed may directly impact marine archaeological features in the North Atlantic EZI. If the component lands on such a feature, there is a possibility that the integrity would be compromised, and significant structural damage could occur. The likelihood of this is reduced where such infrastructure is buried, however for the purpose of this assessment it is assumed that they are not buried. If a marine archaeological feature were compromised it would not be possible to tolerant, adapt, or recover from the impact.

10.10.114 Due to the high value, and lack of tolerance, adaptability, and recoverability from the worst-case scenario effects, marine archaeological features are considered to have high sensitivity to direct impact via deposition of material on the seabed.

10.10.115 The Proposed Project will have a maximum of up to 10 launches per year. Although the licence term has a high longevity, with many associated launches, the likelihood of the Orbex PRIME Launch Vehicle components impacting the same marine archaeological features is negligible considering the total extent over which the components could enter the marine environment. Therefore, the frequency of the impact has been reduced to low to reflect this.

10.10.116 It is anticipated that the maximum size of any single component that comes to rest on the seabed will be a maximum 13.7 m x 1.45 m, to which the footprint of the impact will be limited. The Orbex PRIME Launch Vehicle components are expected to sink through the water column and come to rest at a single place at the seabed, and not move once at the seabed, thereby only impacting the features directly within the footprint the receptor will therefore be impact over a low spatial scale.

10.10.117 An overall high longevity, low frequency and low spatial extent result in a low exposure of marine archaeological features to direct loss caused by the returning component.

10.10.118 There is no natural variation in the presence of marine archaeological features although the amount of coverage by sediment may vary with time. Any potential impact to marine archaeological features would cause a measurable change to the baseline, though it is noted that there may not be a record of this change the eventual location of the component will not be monitored. In addition, it is noted that, considering the small footprint of the impact, and the total area over which the Orbex PRIME Launch Vehicle component may return, the likelihood of the impact occurring is extremely low. Therefore, the magnitude of impact is low.

10.10.119 High sensitivity, combined with low exposure and low magnitude, mean that the risk to marine archaeological features from direct impact of returning Orbex PRIME Launch Vehicle components is minor. No likely significant effect.

Aeronautical Events – Water Strike Following Failure During Flight

10.10.120 Chapter 9 Accidents and Disasters of this AEE considers major accidents that could occur during the project life cycle, in terms of those with serious effects on the environment. One type of accidental event would be an off-nominal flight failure resulting in impact of the Orbex PRIME Launch Vehicle with the marine environment. The predicted magnitude of effects of such an event are not considered ‘major’, therefore an assessment of the effects of failure during flight has been considered in this chapter, rather than Chapter 9.

10.10.121 There is the potential for failure of the Orbex PRIME Launch Vehicle during flight. The worst-case scenario would be the loss of the entire Orbex PRIME Launch Vehicle before any of the routine separation phases, as this would lead to the maximum quantity of Orbex PRIME Launch Vehicle material potentially entering the marine environment at a single location, i.e., impact zone.

10.10.122 Due to their northerly trajectory and flight planning strategy, Orbex PRIME Launch Vehicles are mainly above water once they have left the Proposed Project, therefore it is assumed that any failure during would result in the Orbex PRIME Launch Vehicles entering the marine environment rather than coming down over land. The receiving marine environment of any flight failures is described in Appendix 10.1.

10.10.123 Failure during flight could potentially result in the Orbex PRIME Launch Vehicle entering the marine environment whole at a single impact sit with close to propellent quantities close to maximum. It is anticipated that the maximum footprint of the Launch Vehicle coming to rest on the seabed will be a maximum 20.4 m × 1.45 m. The Orbex PRIME Launch Vehicle components are expected to sink through the water column and come to rest at a single place at the seabed, and not move once at the seabed, thereby only impacting the features directly within the footprint the receptor will therefore be impact over a low spatial scale.

10.10.124 There is one difference to the impact assessment of the full Orbex PRIME Launch Vehicle compared to the first stage only; consideration of propellant left upon re-entry. In the case of a failure during flight, it is possible that the vast majority of the propellant will be unused and therefore could enter the marine environment.

This would be the worst-case scenario in terms of potential hydrocarbon pollution to the marine environment. Assuming that the amount of propellant at launch remains in the Orbex PRIME Launch Vehicle, there is the potential for up to 5,474 kg of LPG to enter the marine environment. The environmental effects are still predicted to be low (as per the assessment of this pathway), due to the extremely low likelihood of occurrence and as propellant in gaseous form is likely to exit the marine environment into the atmosphere. Therefore, there is predicted to be minor risk to the environment as a result of fuel release due to Orbex PRIME Launch Vehicle flight failure.

10.10.125 Therefore, it is considered that the results of the impact assessment detailed in the previous sections are applicable here. The conclusion of negligible or minor risk of likely significant effect on the receptors is considered applicable. No likely significant effect.

10.11 Additional Mitigation

10.11.1 No additional mitigation has been proposed to mitigate the effects from the aforementioned pathways.

10.12 Residual Effects

Effects on Water and Sediment Quality and, Ecological Receptors from Fuel Spillage

10.12.1 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. No likely significant effect.

Effects on Water and Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination

10.12.2 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. No likely significant effect.

Effects on Water and Sediment Quality, and Ecological Receptors from Debris and Microplastics (Including Ingestion)

10.12.3 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. No likely significant effect.

Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed

10.12.4 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. No likely significant effect.

Direct Strike

10.12.5 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. No likely significant effect.

Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface

10.12.6 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. No likely significant effect.

Thermal Effects from Jettisoned Objects

10.12.7 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. No likely significant effect.

Visual Disturbance

10.12.8 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. No likely significant effect.

Displacement of Fish

10.12.9 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. No likely significant effect.

Damage to Human Infrastructure (Subsea Cables/Pipelines)

10.12.10 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. No likely significant effect.

Interference with Military Exercise Areas

10.12.11 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. No likely significant effect.

Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic

10.12.12 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is negligible. No likely significant effect.

Damage to Marine Archaeology/Shipwrecks

10.12.13 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. No likely significant effect.

Aeronautical Events – Water Strike Following Failure During Flight

10.12.14 No additional mitigation is required to mitigate this impact. The residual risk of the impact pathway is minor. No likely significant effect.

10.13 Cumulative Assessment

10.13.1 The cumulative assessment aims to determine the potential for effects of the Proposed Project to combine with other 'reasonably foreseeable projects and plans'. Reasonably foreseeable projects can comprise projects that are planned but not yet operational, be they under construction, or under approval for construction. Projects and plans that are fully implemented and in operation are not considered under the cumulative assessment as they will have been considered under the baseline environment within each of the chapters.

Identification of Projects and Plans

10.13.2 The key sources utilised to provide a long list of reasonably foreseeable plans and projects are:

- 4C Offshore Global Offshore Wind Map;

- Submarine Cable Map;
- KIS-ORCA Offshore Renewables and Cables Awareness;
- Marine Scotland’s National Marine Plan interactive site;
- The Crown Estate Scotland maps;
- UK North Sea Transition Authority;
- Norwegian Petroleum Directorate;
- NATO exercises website (https://shape.nato.int/nato-exercises); and
- Shetland Islands Draft Regional Marine Plan.

10.13.3 All reasonably foreseeable plans and projects that have the potential to act cumulatively with the marine effect pathways associated with the Proposed Project are presented in Table 10.8. Plans and projects have been identified for offshore wind, marine renewables, oil and gas, and subsea cables. With regard to the sectors of military, recreation and tourism, and disposal sites, no proposed plans or projects have been identified.

10.13.4 Shipping and navigation, commercial and recreational fishing, and tourism, have not been considered as future projects and plans for the purposes of this cumulative assessment. Although it is understood that these sectors may increase over time in the North Atlantic EZI, this is not as part of any specific plan or project. The potential impacts to these receptors as a result of cumulative effects has been considered.

10.13.5 Table 10.9 details which of the effect pathways included in the assessment are applicable to each of the projects or plans. The pathways which have the potential to act cumulatively between the Proposed Project and the reasonably foreseeable projects and plans have been taken forward in the assessment.

Table 10.8 All reasonably foreseeable plans and projects in the Environmental Zone of Influence

Plan/Project	Description	Location	Stage	Source
UK Offshore Licensing Round for Oil and Gas	There have been several UK Offshore Licensing rounds for Oil and Gas in recent years, most recently the 33rd Offshore Licensing Round in 2022/23. These licensing rounds have included blocks and part-blocks in the North Atlantic EZI. It is likely that a proportion of these recently licensed blocks will be developed, either by drilling exploration wells, undertaking seismic surveys, or field development planning.	West of Shetland, Faroe-Shetland Basin, East Shetland Platform	Exploration and Pre-development	North Sea Transition Authority (NSTA) (2023)
Faroese Licensing Round for Oil and Gas	Similar to the UK, the Faroe Islands also undertakes licensing rounds for its offshore oil and gas blocks. In 2019 the 5th Faroese Licensing Round occurred, in conjunction with the UK's 32nd Licensing Round. The blocks on offer were near to the boundary of the UKCS. There is therefore potential for future oil and gas exploration and production in these blocks.	Faroese waters of the North Atlantic EZI, specifically in the south-west of the North Atlantic EZI near the border with the UKCS	Exploration and Pre-development	Jardfeingi (2019)
Faroe Islands marine renewable energy	Minesto have signed an agreement to install two tidal kites in Faroese waters. Site development is in progress; installation of the first kite happened in Q2 2020, with the second unit also planned for 2020.	Faroese coastal waters, just outside the North Atlantic EZI	Pre-construction	Minesto (2020)
CANAT 3 SEG F3C Telecom Cable	Telecom cable operated by Faroese Telecom, overlapping with the North Atlantic EZI	Faroese offshore waters, within the North Atlantic EZI	Active	KIS-ORCA (2025)
DANICE SEG 1 Telecom Cable	Telecom cable operated by Farice, overlapping with the North Atlantic EZI	Faroese offshore waters, within the North Atlantic EZI	Active	KIS-ORCA (2025)
FARICE Telecom Cable	Telecom cable operated by Farice, overlapping with the North Atlantic EZI	Faroese offshore waters, within the North Atlantic EZI	Active	KIS-ORCA (2025)

Plan/Project	Description	Location	Stage	Source
Leif Erikson Telecom Cable	Telecom cable operated by Bulk Infrastructure, overlapping with the North Atlantic EZI	North and West Shetland Shelf Offshore Marine Region, within the North Atlantic EZI	Pre-operation	Subsea Cable Map (2025)

Table 10.9 Screening exercise assessing which of the pressures relevant to the Proposed Project apply to other projects screened in for cumulative assessment

Key: ✓ = pressure applied to both projects; ✗ = no exposure pathway for this pressure from the other project

Plan/Project	Fuel Spillage	Metal Corrosion	Microplastics	Disturbance/ Displacement/ Interference	Impact At Seabed	Direct Strike
UK Offshore Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	✗
Faroese Licensing Round for Oil and Gas	✓	✓	✓	✓	✓	✗
Faroe Islands marine renewable energy	✗	✓	✗	✓	✓	✗
CANAT 3 SEG F3C Telecom Cable	✗	✓	✗	✓	✓	✗
DANICE SEG 1 Telecom Cable	✗	✓	✗	✓	✓	✗
FARICE Telecom Cable	✗	✓	✗	✓	✓	✗
Leif Erikson Telecom Cable	✗	✓	✗	✓	✓	✗

Methodology

10.13.6 The potential cumulative effects of the plans and projects listed in Table 10.8 are considered on individual receptors in the subsequent sections. It should be noted that there is limited information on the plans and projects that are less progressed, and therefore less certainty on the potential cumulative effects of the projects.

10.13.7 As part of the AEE Report, the effect upon a receptor may be concluded as negligible or minor risk. However, an effect that has negligible or minor risk from the project alone cannot be ruled out from the cumulative assessment as there is the potential for an increased risk as effects may accumulate with other plans or projects. Therefore, all effects for which there are pathways with the receptors have been considered.

10.13.8 The assessment of cumulative effects between the project and the associated EZI and other plans and projects takes into account the:

- Potential for project/plan effect envelopes to overlap temporally and spatially with a specific receptor;
- Magnitude of cumulative effect (where known or possible to deduce); and
- Receptor-specific sensitivity (including their value), as determined as part of the AEE Report process.

Assessment

10.13.9 In recognition of the level of information availability regarding the projects screened into this assessment, a detailed matrix-based risk (impact) assessment (see methodology detailed in Section 10.4) is not feasible. Expert judgment is used to consider all information available and determine the potential for combination of effects to cause increased effects on regional fish and shellfish populations.

Water Quality

10.13.10 Sections 10.9.5,10.9.16 and 10.9.23 provide a risk assessment of the potential impacts on the water quality environment from the Proposed Project. The potential effects on water quality are the increase in hydrocarbons from fuel spills, metal from corrosion, and microplastics.

10.13.11 All projects and plans detailed in Table 10.9 all comprise construction in the marine environment. The primary material used for construction will be metals for most projects (such as oil and gas, offshore wind etc), with subsea cables comprising plastic (on the outer layer) and metal. All infrastructure placed in the marine environment as part of these projects will have been designed to have a long lifespan with minimal breakdown as this would impact infrastructure integrity. Therefore, the combined input of metals and microplastics as a result of identified projects in combination with the Proposed Project is negligible. No likely significant effect.

10.13.12 Microplastics may enter the marine environment from offshore platforms as part of the waste produced e.g., wastewater. However, this is controlled by international regulations and standard operating procedures to minimise the input (Press and Journal, 2018), therefore this input of microplastics alongside the Proposed Project is considered negligible. No likely significant effect.

10.13.13 Of the additional plans and projects, significant input of hydrocarbons will likely only arise from oil and gas operations. Hydrocarbons can enter the marine environment through accidental events such as spills or intentional means such as through the deposition of drill cuttings at the seabed. The oil and gas sector is governed by international regulations on drill cuttings (OSPAR Decision 2000/3 and Recommendation 2006/5) and has standard operating procedures to reduce the likelihood and severity of oil spills, thereby minimising the potential for hydrocarbon input into the marine environment. Taking into account the low likelihood and severity of hydrocarbon input from oil and gas projects, as well as the proposed launches, the in-combination risk is considered negligible. No likely significant effect.

Biodiversity Receptors

10.13.14 The potential effects on biodiversity receptors are the increase in contaminants (hydrocarbons, metal, microplastic), direct strike from components, disturbance and displacement from components, payloads and vessels, and direct loss of seabed habitat.

10.13.15 The results of the assessment of cumulative effects on water quality as a result of contaminant pathways is directly applicable to the biodiversity receptors within the marine environment. Accordingly, there is negligible risk of cumulative effects on biodiversity receptors as a result of contaminants from the Proposed Project in-combination with other reasonably foreseeable plans and projects. No likely significant effect.

10.13.16 The other projects and plans that also have the potential to result in direct strike of marine ecological receptors are tidal arrays. Historically, the risk of collision from tidal array has been of concern during developments and has resulted in significant pre-construction modelling and post-construction monitoring. At present there is still poor understanding of the real-life level of collision risk for marine ecological receptors. It is noted that, with regards to marine mammals, there have been no reports of collisions as the animals have been shown to instead display an avoidance response (NERC, 2013). Even though there is limited information, it is likely that the number of individuals lost from a population as a result of tidal turbines is low. To illustrate, collision risk modelling for MeyGen, Pentland Firth, Scotland, concluded that up to 243 salmon would collide with an array of 200 turbines per year. The number of individuals from other receptor groups that may be affected is likely to be much smaller (it is high in fish due to shoaling behaviour). In addition, the number of individuals affected is further reduced as it is highly unlikely that any tidal arrays in the North Atlantic EZI would comprises such a large array of turbines. The subsequent low number of affected individuals is anticipated to comprise a negligible proportion of the marine ecological receptor populations in the North Atlantic EZI. Therefore, it is considered that the risk of mortality as a result of direct strike from the Proposed Project in combination with other projects is negligible. No likely significant effect.

10.13.17 The projects and plans detailed in Table 10.8 have the potential to disturb marine ecological receptors through either visual pathways, i.e. physical presence of the infrastructure and associated vessel traffic, or acoustic pathways i.e. through underwater noise emitted. The area of displacement associated with these projects is anticipated to be similar in scale to the displacement for the proposed project i.e., no more than several kilometres around the disturbance source. Perhaps one type of activity which could lead to larger areas of disturbance is piling, which can be used for fixing infrastructure to the seabed such as offshore wind or tidal devices, however it is not known if piling will be used for the additional projects. It is considered highly unlikely that the area of disturbance around a project or plan will overlap with the area of disturbance around returning Orbex PRIME Launch Vehicle component, due to the safety issue of being nearby a returning launch vehicle. Therefore, the area of displacement is unlikely to increase due to two potential sources of effects within a single disturbance zone. For other identified projects, there is the potential that the disturbance zones around projects in the North Atlantic EZI will be additive, increasing the total amount of area from which a marine ecological receptor is displaced. However, given the total habitat available to marine ecological receptors across the North Atlantic EZI, this is determined to have negligible risk at the population-level. No likely significant effect.

10.13.18 The benthic habitat in the North Atlantic EZI comprises predominantly deep-sea habitats that are expected to be homogeneous. Also present in the North Atlantic EZI are sensitive benthic habitats, VMEs and MPA features, however these are widespread and large in spatial extent, respectively. The majority of projects and plans detailed in Table 10.8 will have a limited seabed footprint as they comprise a single impact area, single infrastructure or a series of single infrastructure. The exception is the Celtic Norse subsea cable, which will have a considerably larger seabed footprint. All these projects will be required to undertake an assessment of the seabed conditions prior to development, including an assessment of benthic habitats with focus on any protected species or habitats. Should protected habitats be discovered, it is anticipated that the project location will be amended to minimise effects, as per international regulations and best practice. Therefore, due to the minimised effect from the proposed projects and plans, in conjunction with the extremely low likelihood of effect from the Proposed Project, the cumulative risk is considered negligible. No likely significant effect.

Human and Human Activities

10.13.19 The potential effects on humans and human activities are direct impact from Orbex PRIME Launch Vehicle components at the seabed and disturbance and displacement from the Orbex PRIME Launch Vehicle itself.

10.13.20 The two human activities which may be affected by pathways at the seabed are subsea cables and pipelines and marine archaeology. All of the proposed projects and plans detailed in Table 10.8 will result in some level of seabed disturbance due to emplacement of infrastructure. However, as the existing infrastructure at the seabed described in the baseline are already known, they will form part of the baseline assessment of future projects, prior to construction at the seabed. Therefore, avoidance of infrastructure should occur and negate the possibility that future projects and plans will affect pre-existing infrastructure at the seabed, such as subsea cables. Therefore, there is no pathway for these projects to act cumulatively with effects from launch operations as a result of Proposed Project. Similarly, future projects and plans will have to undertake an assessment of the presence of marine archaeological features in the project footprint and minimise effects to these features through amending the location. Therefore, the likelihood that the proposed plans and project detailed in Table 10.8 will affect the marine archaeological features that have the potential to interact with the launch operations from the Proposed Project is mitigated through accepted best practice planning procedures and assessments.

10.13.21 The human and human activities in the North Atlantic EZI that utilise vessels have the potential to be affected via disturbance. Disturbance from the Proposed Project can arise during the return of Orbex PRIME Launch Vehicle components. An exclusion zone will be implemented around returning launch items, thereby excluding other human activities from the area on a temporary basis (the exact duration is not yet known). It is likely that future infrastructure projects (except subsea cables) will also implement an exclusion zone around the infrastructure, to ensure safety to navigation in their immediate vicinity (noting that subsea cable installation vessels also implement safety exclusion zones whilst installing the cables). In the case of oil and gas offshore platforms, such safety zones are typically 500 m (Step Change in Safety, 2017). The spatial extent of the area from which vessels are excluded will therefore be added to by each infrastructure project and associated exclusion zone. The cumulative area of exclusion is anticipated to be small in the context of the total area of navigation available to vessels. In the case of commercial fishing vessels, cumulative displacement from fishing grounds can result in loss of income as catch per unit effort is likely to be reduced. However, the exclusion zones around other future infrastructure will be permanent, as opposed to the temporary exclusion zone for the Proposed Project, therefore the fishers will have already modified their fishing areas to accommodate these zones. It is considered that the small size of the area of exclusion in the context of total area available to navigation, or the area available for fishing, will result in a negligible cumulative risk of the Proposed Project with other projects and plans. No likely significant effect.

Conclusion

10.13.22 Negligible risk has been determined for all receptors screened into this assessment for in combination effects from the Proposed Project with reasonably foreseeable plans and projects. No likely significant effect.

10.14 Summary

10.14.1 This chapter considers the marine and transboundary effects from the Proposed Project. Effects on the marine environment will arise from the return to earth of Orbex PRIME Launch Vehicle components. Such marine effects may occur in Scottish waters or in the waters of other countries (i.e., transboundary effects), specifically; Denmark (Faroe Islands, Greenland), Iceland, and Norway.

10.14.2 The North Atlantic EZI encompasses an area between the SaxaVord Spaceport and approximately 4,007 km north of Launch Pad 3. The North Atlantic and South Pacific EZIs encompass the expected impact zones associated with debris from the first and second stage, interstage, and payload fairing.

10.14.3 The North Atlantic EZI comprises mostly deep water with a small amount of continental shelf and many bathymetric features. The water quality of the North Atlantic EZI is high, in that it does not have significant local input of anthropogenic contaminants such as metals, microplastics, and hydrocarbons. The North Atlantic EZI supports numerous marine biota such as plankton, benthic habitats, fish and shellfish, seabirds, and marine mammals. The North Atlantic EZI has few marine protected areas (Drawing 10.3).

10.14.4 In the North Atlantic EZI, human activities are concentrated in the southern portion (as far as the Faroe Islands to the north). This includes shipping and navigation, oil and gas cables and pipelines, and commercial fishing (Drawings 10.4 – 10.6). There is occasional use of the area for military activities. Marine archaeology is poorly known and so assumed to be present. There is presence of oil and gas infrastructure, subsea cables and pipelines, marine renewable energy, dredge disposal sites, tourism, and marine archaeological features as shown on Drawings 10.4 – 10.6.

10.14.5 Launches have the potential to affect the aforementioned water quality, biodiversity and human activities. The pathways of effect have been identified: impacts from the presence of the Orbex PRIME Launch Vehicle and associated materials, such as metals, microplastics, and hydrocarbons; impacts from direct strike and impact at the seabed from when the returning components come to rest.

10.14.6 The potential impacts on water quality, biodiversity, and human activities in the North Atlantic EZI have been assessed. All pathways have a negligible or minor risk of a likely significant effect on the receptors. No likely significant effect.

10.14.7 Because the risk is negligible or minor there is no requirement to apply mitigation in order to reduce the risk further. Accordingly, the residual effect to the receptors is also negligible or minor. No likely significant effect.

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Chapter 11 Summary of Environmental Effects

11. Summary of Environmental Effects

11. Summary of Environmental Effects

11.1 Introduction

11.1.1 This Summary of Environmental Effects provides a summary of effects of the Proposed Project, mitigation measures and the residual effects anticipated after mitigation measures have been applied.

11.2 Summary of Environmental Effects

11.2.1 Pre-mitigation and residual environmental effects are summarised in Table 11.1. The table provides a concise reference to each of the pre-mitigation and residual environmental effects identified in the technical sections of the AEE Report (with the exception of the Ornithology and Ecology Assessments), as well as a cross reference to the relevant mitigation measures identified.

11.2.2 Table 11.2 below provides a concise reference to each of the residual environmental effects identified to receptors in the Ornithology and Ecology Assessments of the AEE Report.

Table 11.1 – Summary of Pre-mitigation and Residual Environmental Effects

Description of Effect	Pre-mitigation Effect			Mitigation Measure(s)	Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
Climate Change							
GHG emissions arising from operation.	Minor	Adverse	No likely significant effect	Applicant committed to procuring goods and services locally, where feasible.	Minor	Adverse	No likely significant effect
Damage to launch vehicle, pay load and lightning tower and delay of launches due to high wind speeds.	Moderate	Adverse	Potential significant effect	Applicant to suspend launch activities in high winds.	Minor	Adverse	No likely significant effect
Suspension of ferry routes and flights due to high wind speeds will limit access to the Proposed Project for launch cycle personnel and goods.	Minor	Adverse	No likely significant effect	Applicant to source materials in Shetland or as close to the Proposed Project as possible, where applicable.	Negligible	Adverse	No likely significant effect
Heavy precipitation resulting in flooding and erosion of access roads and limiting access for launch cycle vehicles.	Moderate	Adverse	Potential significant effect	SaxaVord Spaceport to maintain drainage system; ditches cut by spaceport operator in the flatter areas to aid drainage into natural streams. Applicant to comply with any relevant operational procedures required to implement and maintain drainage.	Minor	Adverse	No likely significant effect
Water ingress causing failure of electrical equipment (e.g., generators and deluge pumps)	Minor	Adverse	No likely significant effect		Negligible	Adverse	No likely significant effect
High temperatures causing site personnel welfare impacts such as heat stress	Minor	Adverse	No likely significant effect	Applicant to implement health and safety procedures e.g., provision of appropriate PPE.	Negligible	Adverse	No likely significant effect
Overheating of equipment and potential fire due to high temperatures.	Minor	Adverse	No likely significant effect	Deluge pumps to be designed and installed by the Applicant. Deluge system to be maintained by the Applicant and SaxaVord Spaceport.	Negligible	Adverse	No likely significant effect
Air Quality							
Effects at sensitive human receptors from launch event emissions	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Noise							
Non-launch noise from fixed and mobile plant	Minor	Adverse	No likely significant effect	SaxaVord Spaceport has committed to meeting derived noise limits at NSRs and appropriate specification of plant. Applicant to comply with any required noise limits.	Minor	Adverse	No likely significant effect
Noise and vibration from engine test and launches	Minor	Adverse	No likely significant effect	Applicant to engage in clear communication with the local community on the Proposed Project. Likely to fall within the wider SaxaVord Spaceport community engagement program.	Minor	Adverse	No likely significant effect
Road traffic noise	Negligible	Adverse	No likely significant effect	None proposed	Negligible	Adverse	No likely significant effect
Vibration from engine test and launches	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Accidents							
This subject has not been assessed in a manner comparable with other environmental aspects as it considers scenarios which are both theoretical and extreme rather than reasonably expected occurrences. Only the accidents and disaster scenarios considered likely to cause major adverse effects were considered, as is inherent to the scope of the chapter. The pre-mitigation effects are generally major, adverse and significant. Residual effects may remain similarly significant, but this would be predicated on the combined failure of design, operational and physical mitigation measures.							

Description of Effect	Pre-mitigation Effect			Mitigation Measure(s)	Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
Marine and Transboundary Effects							
Effects on Water, Sediment Quality, and Ecological Receptors from Fuel Spillage.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Effects on Water, Sediment Quality, and Ecological Receptors from Metal Corrosion and Toxic Contamination.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Effects on Water, Sediment Quality, and Ecological Receptors from Debris and Microplastics (Including Ingestion).	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Smothering of Marine Organisms, Habitat Alteration (Including Reef Effects) and Habitat Loss via Deposition of Material on the Seabed or Sea Ice.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Direct Strike.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Acoustic Disturbance (including Underwater Noise) from the Impact of the Jettisoned Objects Hitting the Sea Surface or Sea Ice.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Thermal Effects of Jettisoned Objects.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Visual Disturbance.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Displacement of Fish.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Damage to Human Infrastructure (Subsea Cables/Pipelines).	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Interference with Military Exercise Areas	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Impacts to Vessel Navigation Including Floating Debris, Changes to Topography and Re-routing of Vessel Traffic.	Negligible	n/a	No likely significant effect	None proposed	Negligible	n/a	No likely significant effect
Damage to Marine Archaeology/Shipwrecks.	Minor	Adverse	No likely significant effect	None proposed	Minor	Adverse	No likely significant effect
Aeronautical Events – Water Strike following Failure during Flight	Negligible - Minor	Adverse	No likely significant effect	None proposed	Negligible - Minor	Adverse	No likely significant effect

Table 11.2 – Summary of Pre-mitigation and Residual Environmental Effects – Ornithology and Ecology

Description of Effect/Receptor	Significance of Pre-mitigation Effect			Mitigation Measure	Significance of Residual Effect		
	Magnitude	Beneficial/ Adverse	Significance		Magnitude	Beneficial/ Adverse	Significance
Ornithology							
Black Guillemot	Negligible	Adverse	Not significant	SaxaVord Spaceport operates in line with a Breeding Birds Protection Plan informed by, and updated through, targeted breeding bird surveys. Applicant to comply with any relevant operating procedures/controls required as part of the above plan. SaxaVord Spaceport to implement Habitat Management Plan to: ➢ Enhance habitats for species of importance present on, or linked to, the study area. ➢ Restore important habitats and associated species. ➢ Peatland restoration. Applicant to comply with any relevant operating procedures/controls required as part of the above plan.	Negligible	Adverse	Not significant
Common Guillemot	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Puffin	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Razorbill	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Shag	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Kittiwake	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Fulmar	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Merlin	No effect	n/a	Not significant		No effect	N/A	Not significant
Ringed Plover	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Golden Plover	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Dunlin	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Whimbrel	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Curlew	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Arctic Tern	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Arctic Skua	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Great skua	Negligible	Adverse	Not significant		Negligible	Adverse	Not significant
Confidential species	Minor	Adverse	Potentially significant		Negligible	Adverse	Not significant
Ecology							
Designated sites	Negligible	Adverse	Not Significant	Embedded mitigation within the development of SaxaVord Spaceport included: ➢ Construction of ten artificial holts/shelters in suitable locations across the top of Lamba Ness to provide additional resting places away from the coast. ➢ Retention of an important otter underpass. ➢ Enforced low vehicle speed limits (10 mph) would greatly reduce the likelihood of otter injury or death caused by vehicle traffic. ➢ Implementation of the Habitat Management Plan Applicant to comply with any relevant operating procedures/controls required as part of the above plan.	Negligible	n/a	Not Significant
Semi-natural habitats	Negligible	Adverse	Not Significant		Negligible	n/a	Not Significant
Otter	Negligible/ minor	Adverse	Not Significant		Negligible	n/a	Not Significant

11.3 Significant Residual Effects

11.3.1 Post mitigation, there are no remaining significant residual effects.

11.4 Monitoring

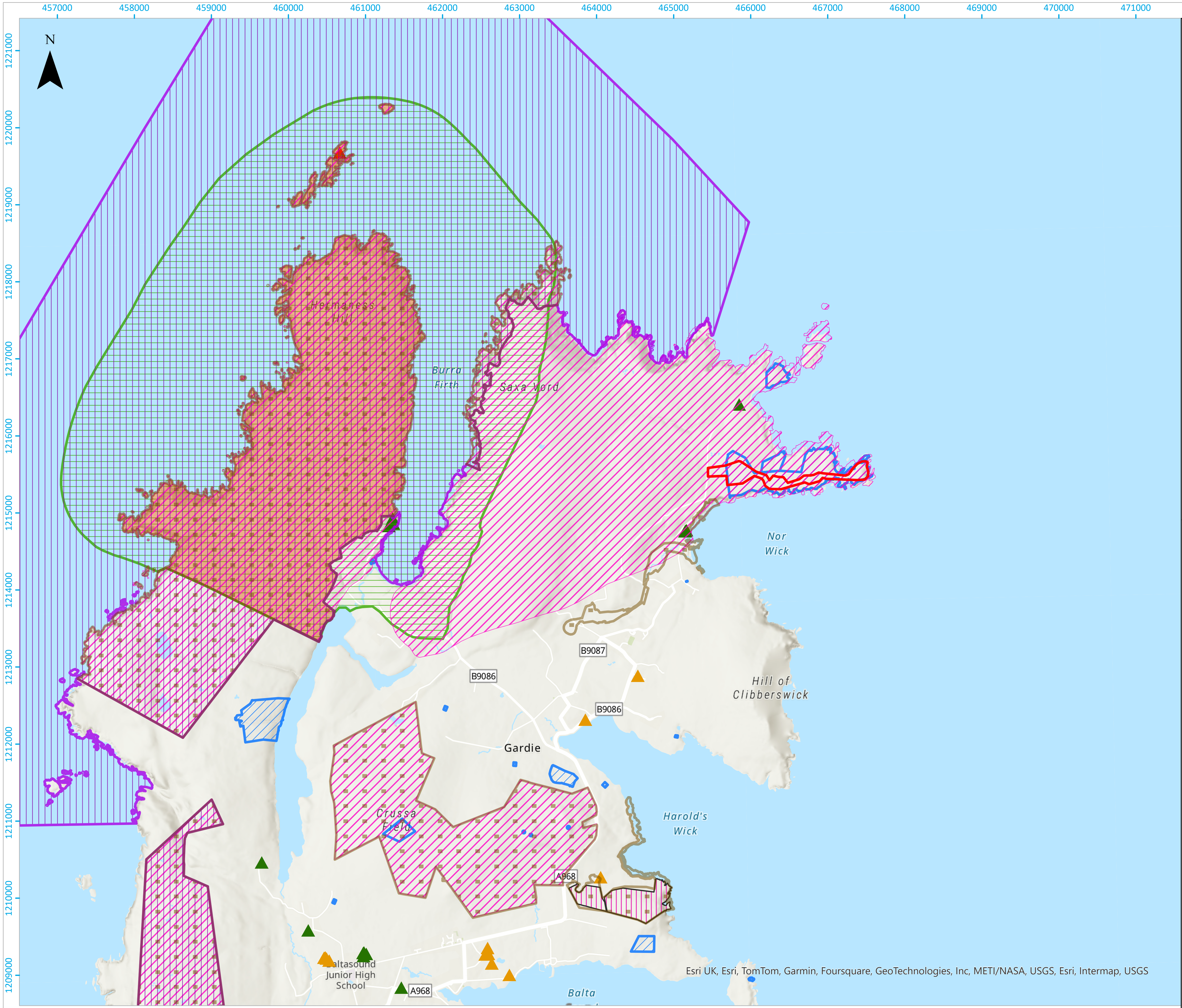
11.4.1 There are no adverse significant residual effects and therefore no monitoring is required as a result of this AEE.

11.5 Conclusion

11.5.1 The conclusion of this AEE is that there are no significant operational effects of concern from the Proposed Project and that the proposed activities will comply with statutory requirements and environmental policy objectives. As described in each of the technical chapters, this takes into consideration international, national and local legislation and objectives.

Volume III AEE Drawings

Chapter 1 Drawing 1.1 Statutory Environmental Designations



KEY

- Proposed Project Boundary
- Site of Special Scientific Interest (SSSI)
- Special Protection Area (SPA)
- Important Bird Areas
- Special Area of Conservation
- National Nature Reserve (NNR)
- National Scenic Area (NSA)
- Scheduled Monument (SM)

Listed Building

- A-Listed Building
- B-Listed Building
- C-Listed Building

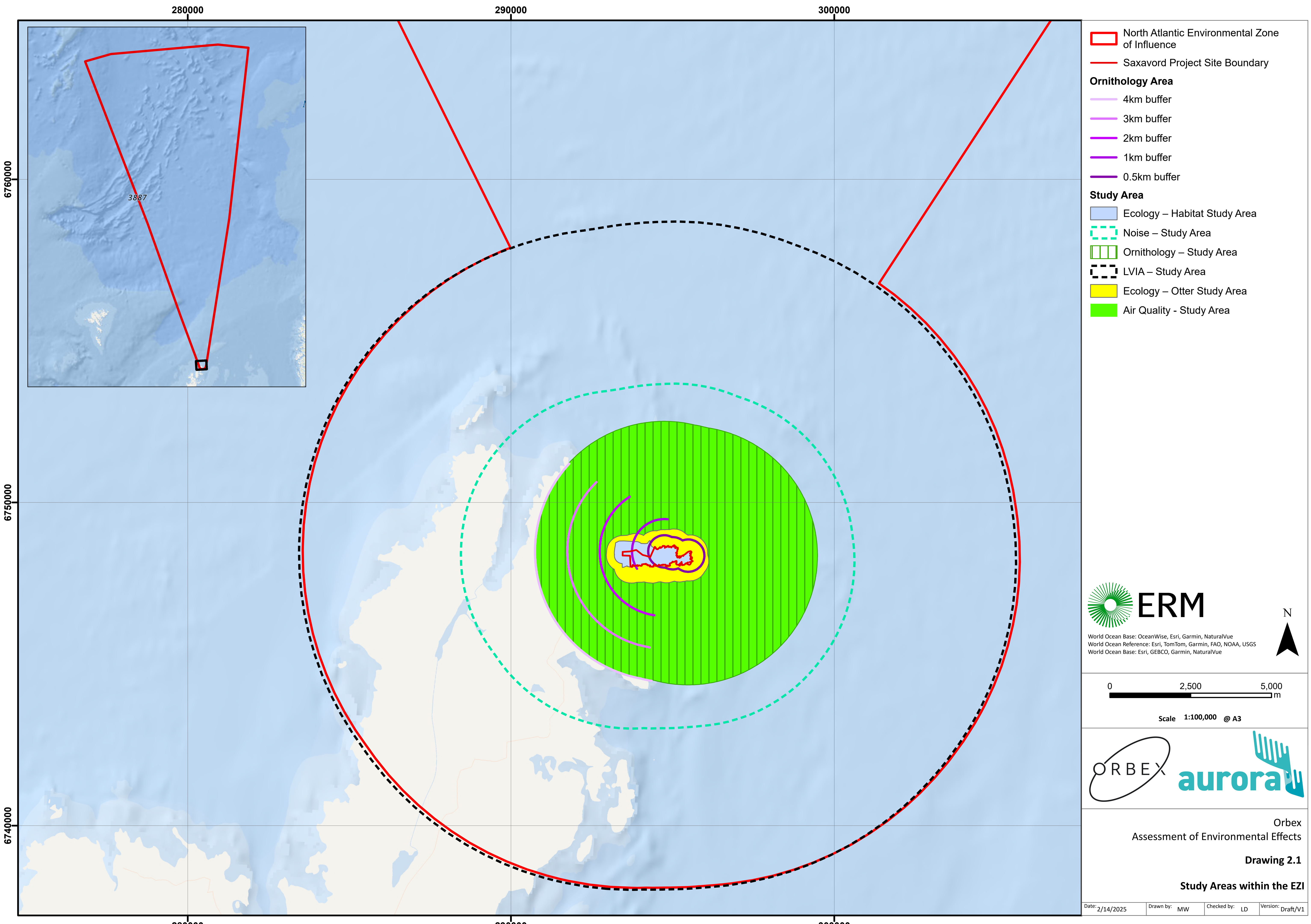
aurora ORBEX

SLR

Orbex PRIME SaxaVord AEE / 413.057914.00001
Assessment of Environmental Effects
Drawing 1.1
Statutory Environmental Designations

Scale	Date
1:500,000 @ A3	FEBRUARY 2025

Chapter 2 Drawing 2.1 Study Areas within the Environmental Zone of Influence



World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Reference: Esri, TomTom, Garmin, FAO, NOAA, USGS
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

Scale 1:100,000 @ A3

Orbex
Assessment of Environmental Effects

Drawing 2.1

Study Areas within the EZI

Date:	Drawn by:	Checked by:	Version:
2/14/2025	MW	LD	Draft/V1

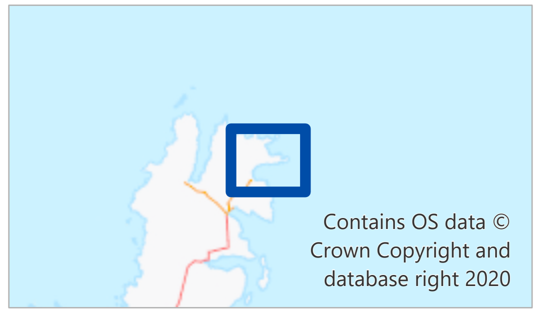
Project Number: 3148

Service Layer Credits: World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Base: Esri, GEBCO, Garmin

Chapter 3 Drawing 3.1 Proposed Project Location

KEY

Proposed Project Boundary



aurora

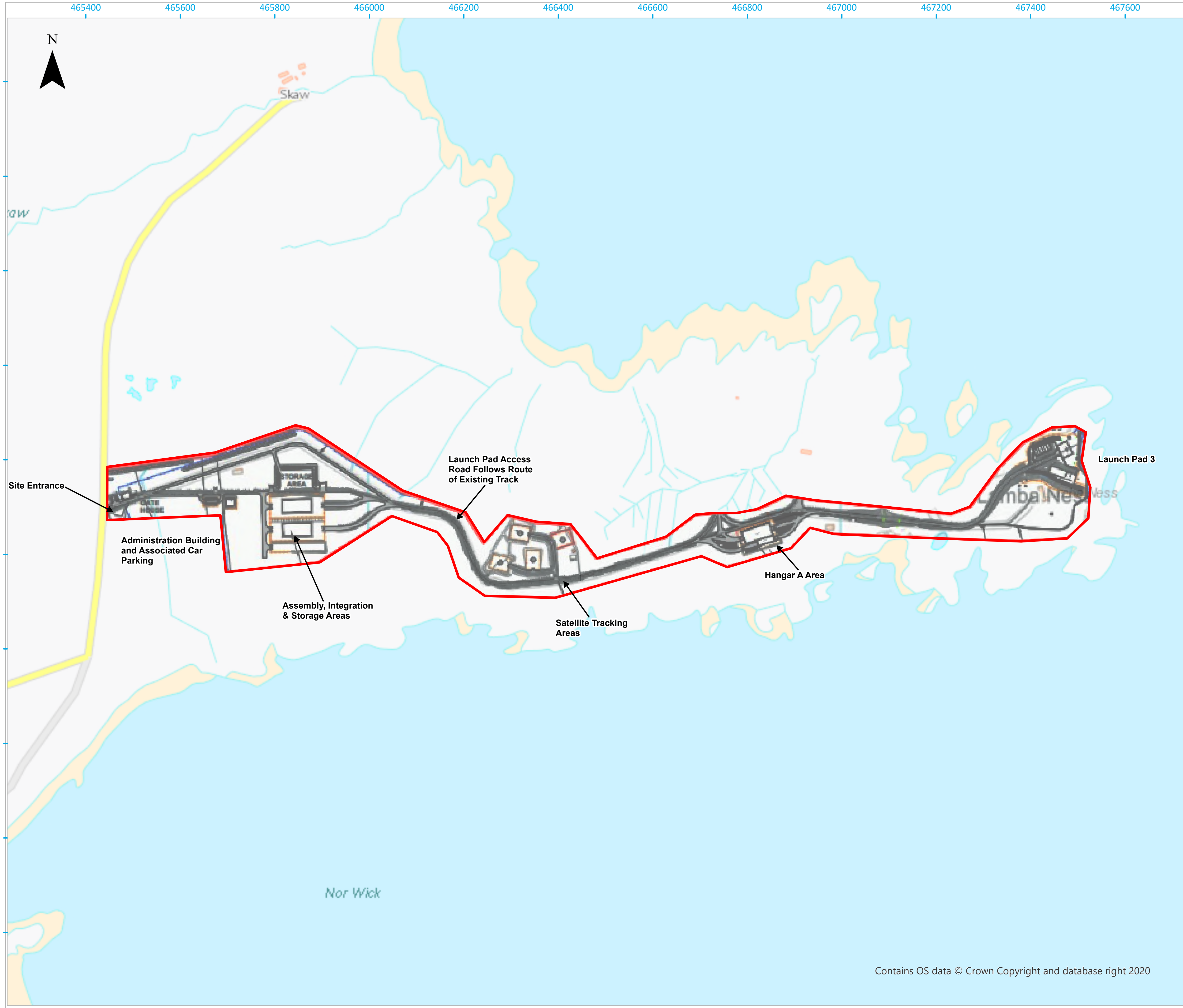
ORBEX

SLR

Orbex PRIME SaxaVord AEE / 413.057914.00001
Assessment of Environmental Effects
Drawing 3.1
Proposed Project Location

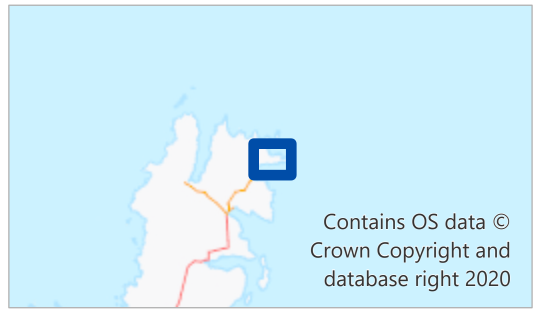
Scale	Date
1:500,000 @ A3	FEBRUARY 2025

Chapter 3 Drawing 3.2 Proposed Launch Site Layout



KEY

Proposed Project Boundary



Orbex PRIME SaxaVord AEE / 413.057914.00001

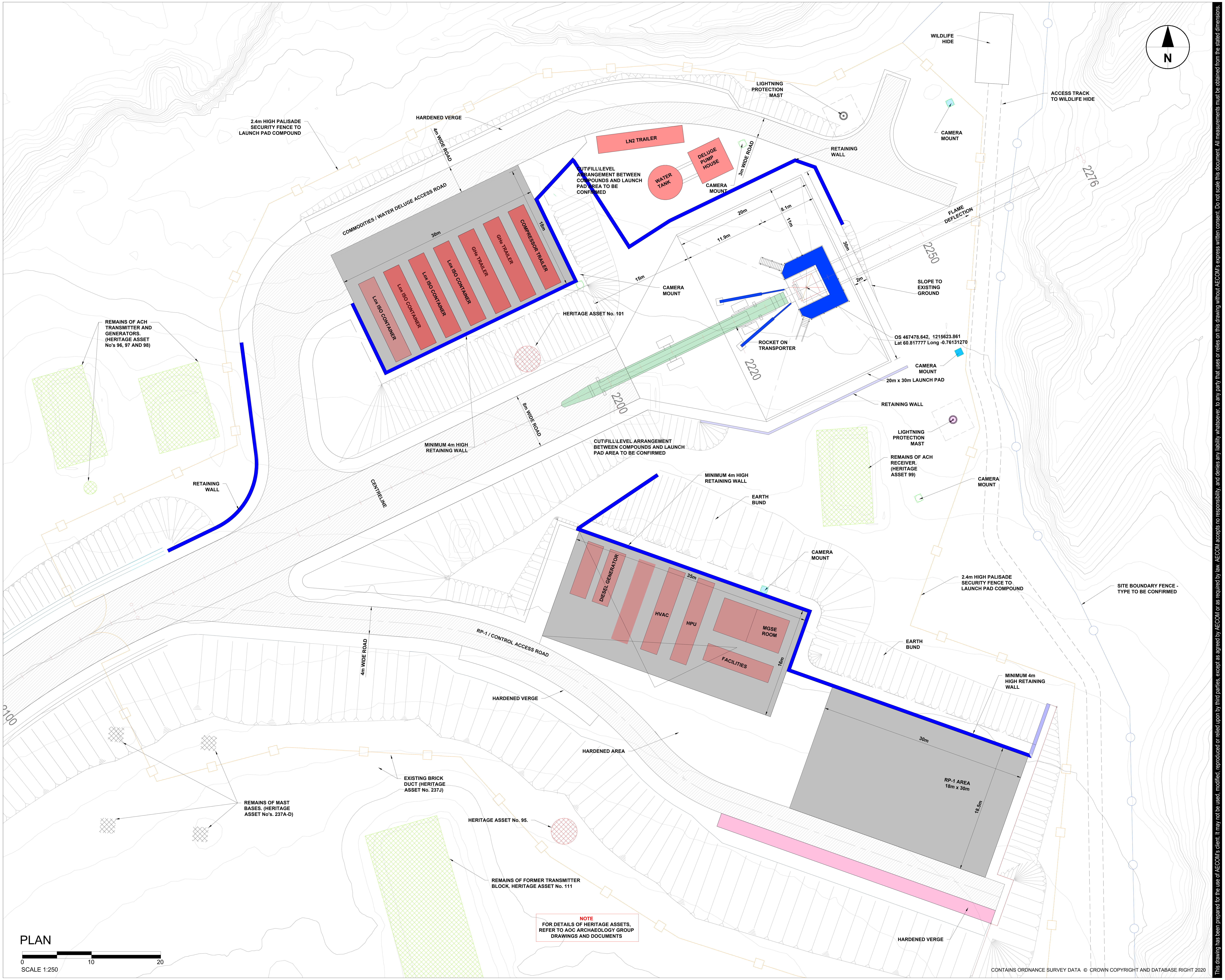
Assessment of Environmental Effects

Drawing 3.2

Predicted Unweighted Lmax Noise Contours for Launch Events

Scale	Date
1:500,000 @ A3	FEBRUARY 2025

Chapter 3 Drawing 3.3 Launch Pad 3 Layout



AECOM

Project

SHETLAND SPACE CENTRE

Client

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Notes

Key Plan

Purpose Of Issue

ORBEX LICENCE APPLICATION AEE

Project Number

Sheet Title

LAUNCH PAD 3 LAYOUT

Sheet Number

DRAWING 3.3

Scale: AS SHOWN **Rev:** -

ISO A1 594mm x 841mm
Approved: CGY
Checked: CGY
Designer: DR
Project Management Initials:

Last saved by: DAVID.RENNIE(2021-10-14) Last Plotted: 2021-10-19
Filename: Z:\UK\UKEDI1\OBS\PR-448651_SSC_ENVIRONMENTAL_STUDY\900_CAD_GIS\910_CAD\DC\DBITP DRAWING 3.5 - REVISED.DWG

Chapter 4 -

Chapter 5 SaxaVord Spaceport Drawing 5.1 Breeding Birds Study Area

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Project Number: 3148

KEY

- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

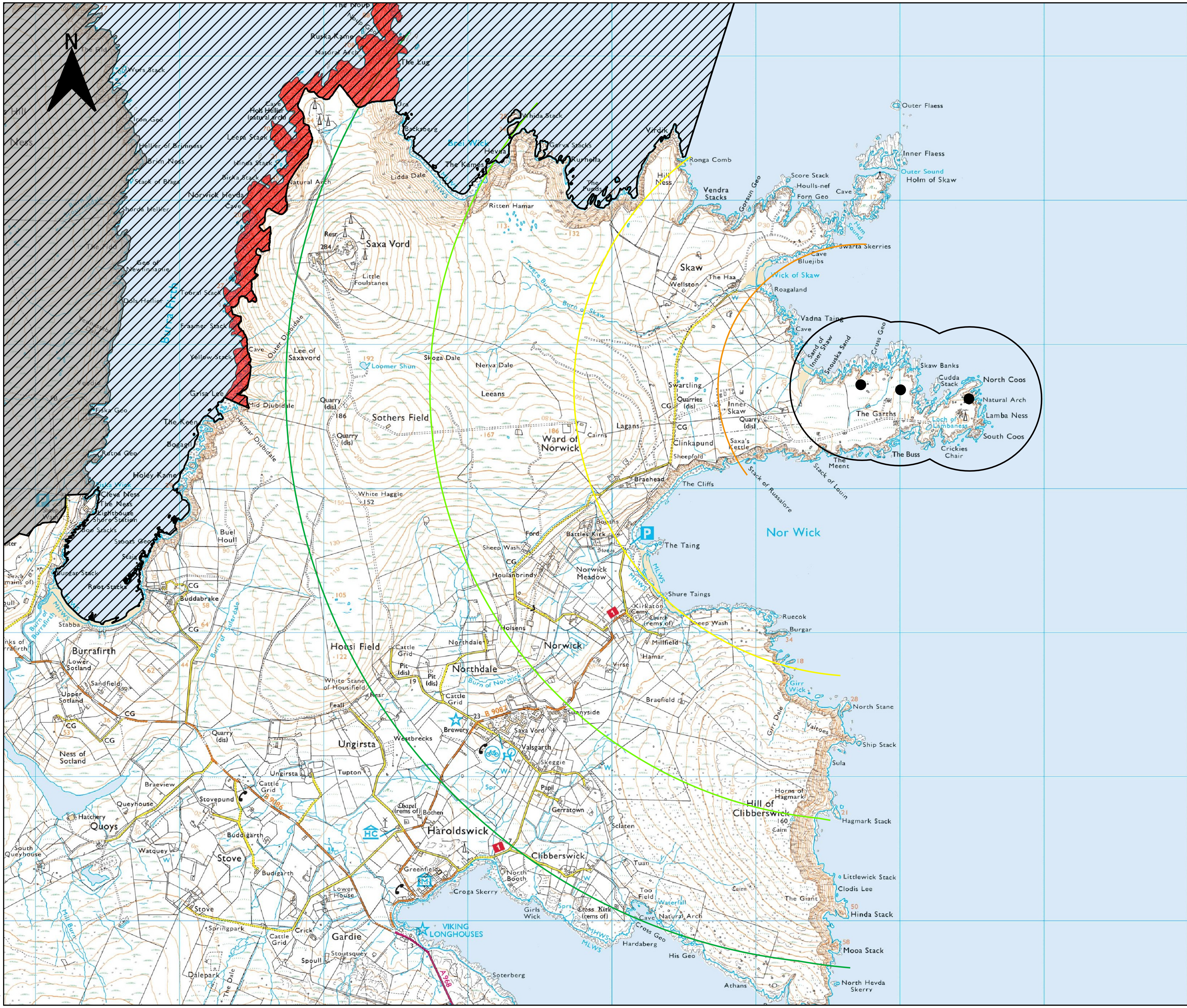
SAXAVORD
UK SPACE PORT

Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.1
Breeding birds Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Chapter 5 SaxaVord Spaceport Drawing 5.2 Designated Sites



KEY

- Hermaness, Saxa Vord and Valla Field SPA
- Hermaness SSSI
- Saxa Vord SSSI
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SAXAVORD UK SPACE PORT

Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.2
Designated sites within ornithological Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.3 Breeding Black Guillemot within EZI

KEY

- Black guillemot individuals
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SAXAVORD UK SPACE PORT

Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.3
Breeding black guillemot within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.4 Breeding Shag within EZI

KEY

- ▲ Shag Apparently Occupied Nests
- Proposed Project Site Boundary
- ● Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

SAXAVORD UK SPACE PORT

Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.4
Breeding shag within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.5 Breeding Fulmar within EZI

KEY

- Fulmar Apparently Occupied Nests
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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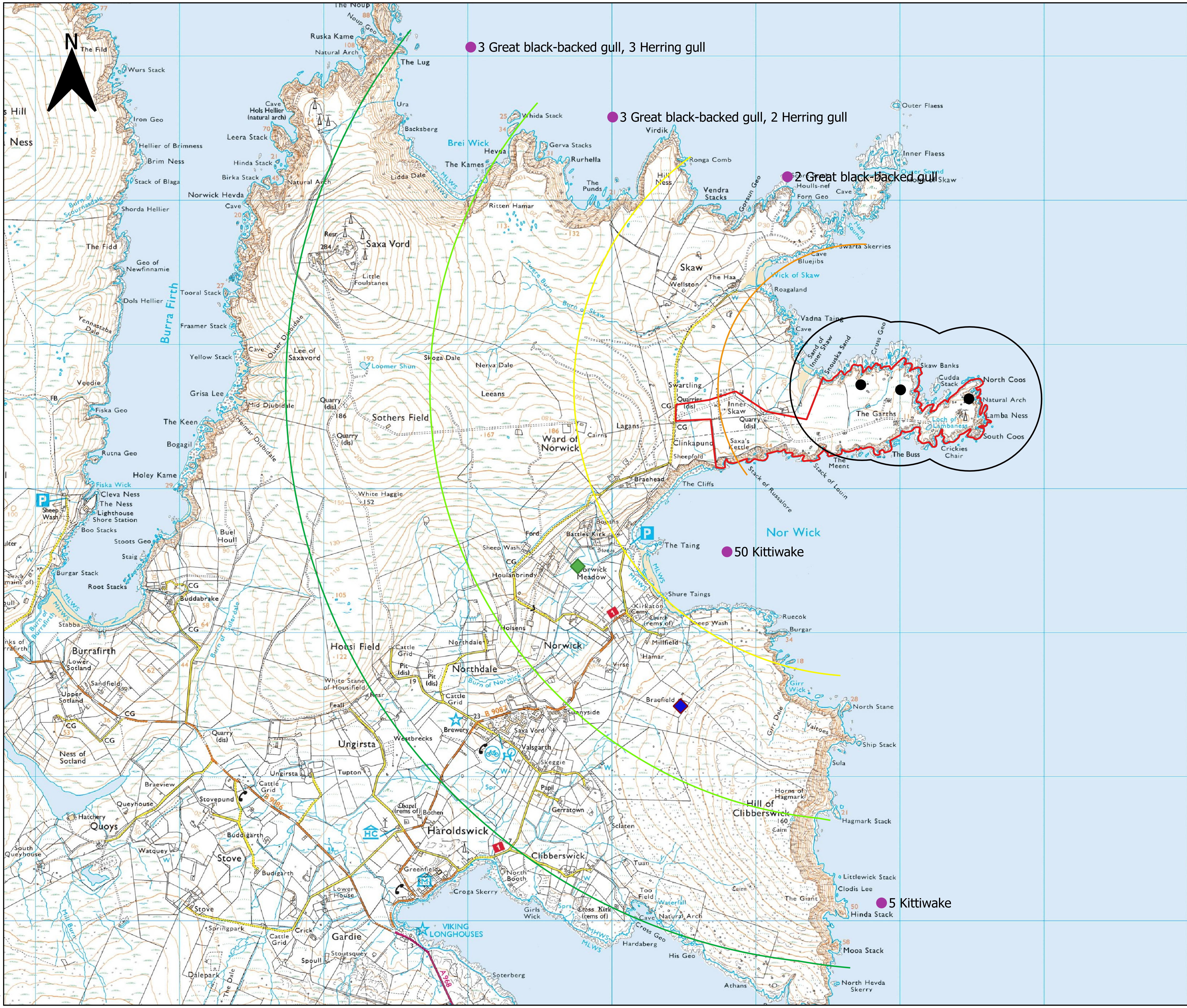
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.5
Breeding fulmar within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.6 Breeding Gulls within EZI



KEY

Nesting gulls (boat surveys)

Mixed inland gull colony

Lesser black-backed gull
2018 - 12 pairs
2019 - 10 pairs

Herring gull
2018 - 10 pairs
2019 - 16 pairs

Common gull
2018 - 22 pairs
2019 - 30 pairs

Black-headed gull colony
2018 - 11 pairs
2019 - 13 pairs

Proposed Project Site Boundary

Launch pad

0.5km buffer launch pads

1km buffer launch pads

2km buffer launch pads

3km buffer launch pads

4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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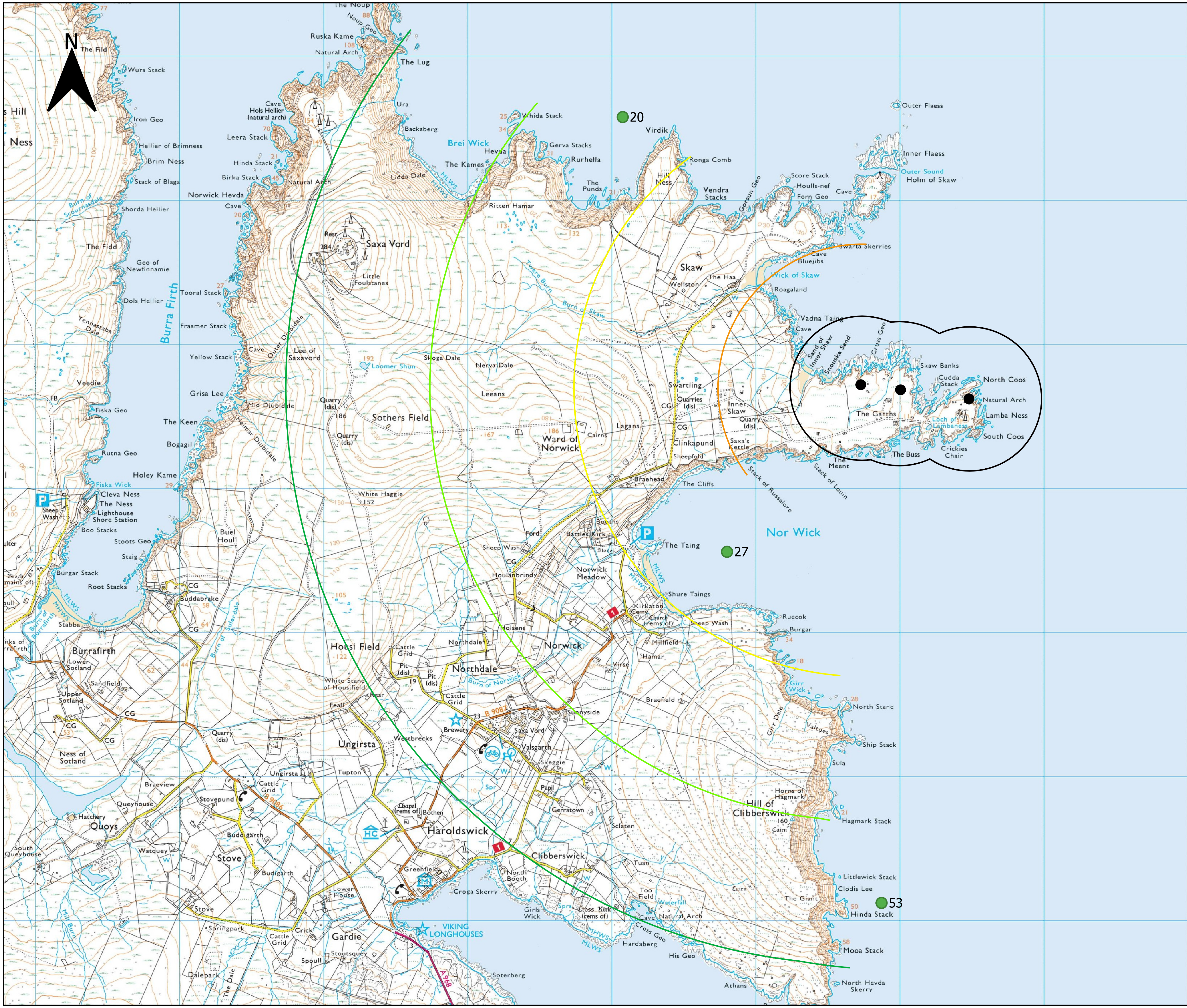
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.6
Breeding gulls within the Study Area

Date: 16/11/2021	Drawn by: K.M.	Checked by: P.C.	Version: Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.7 Breeding Common Guillemot within EZI



KEY

- Common guillemot individuals
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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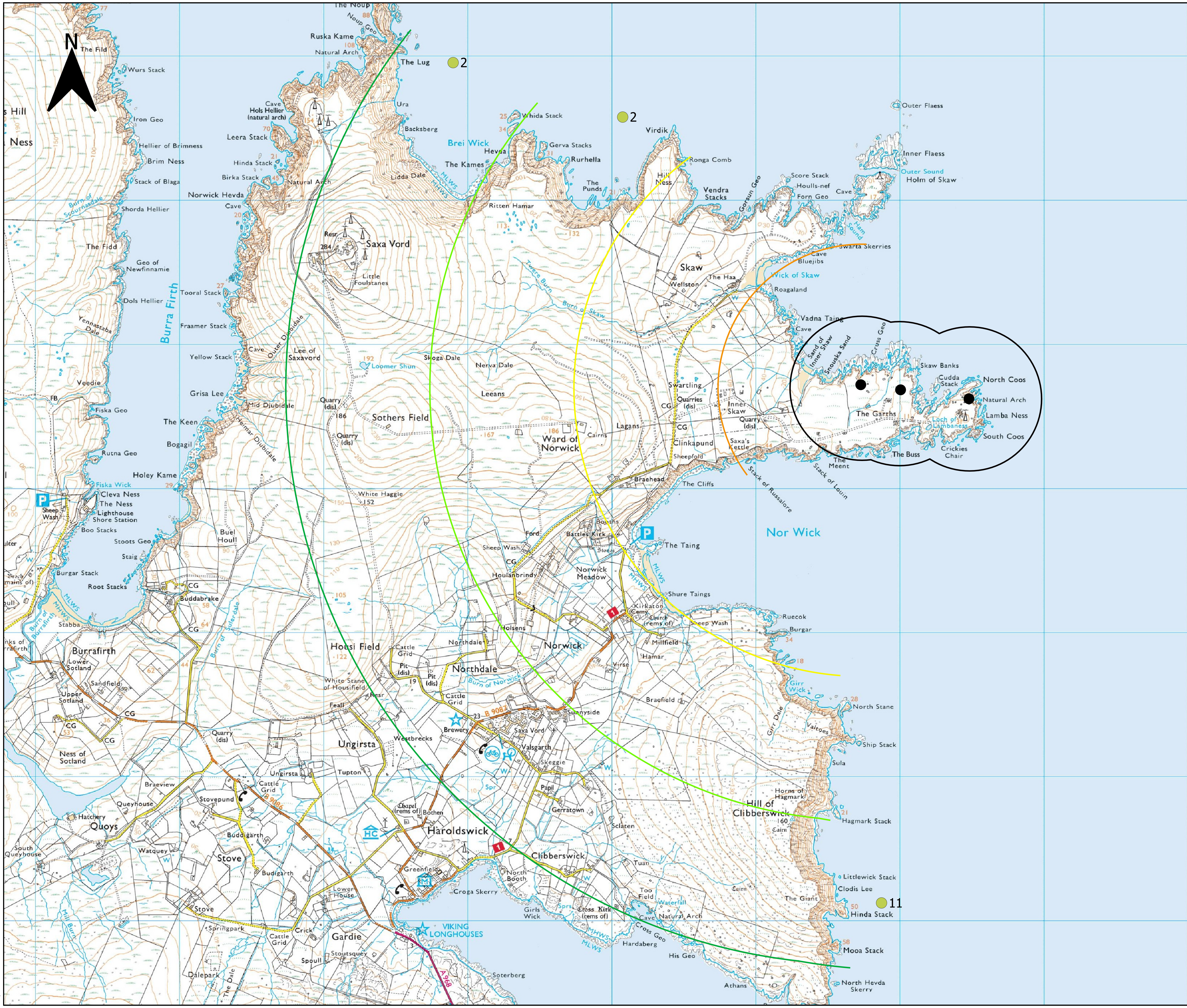
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.7
Breeding common guillemot within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.8 Breeding Razorbill within EZI



KEY

- Razorbill individuals
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

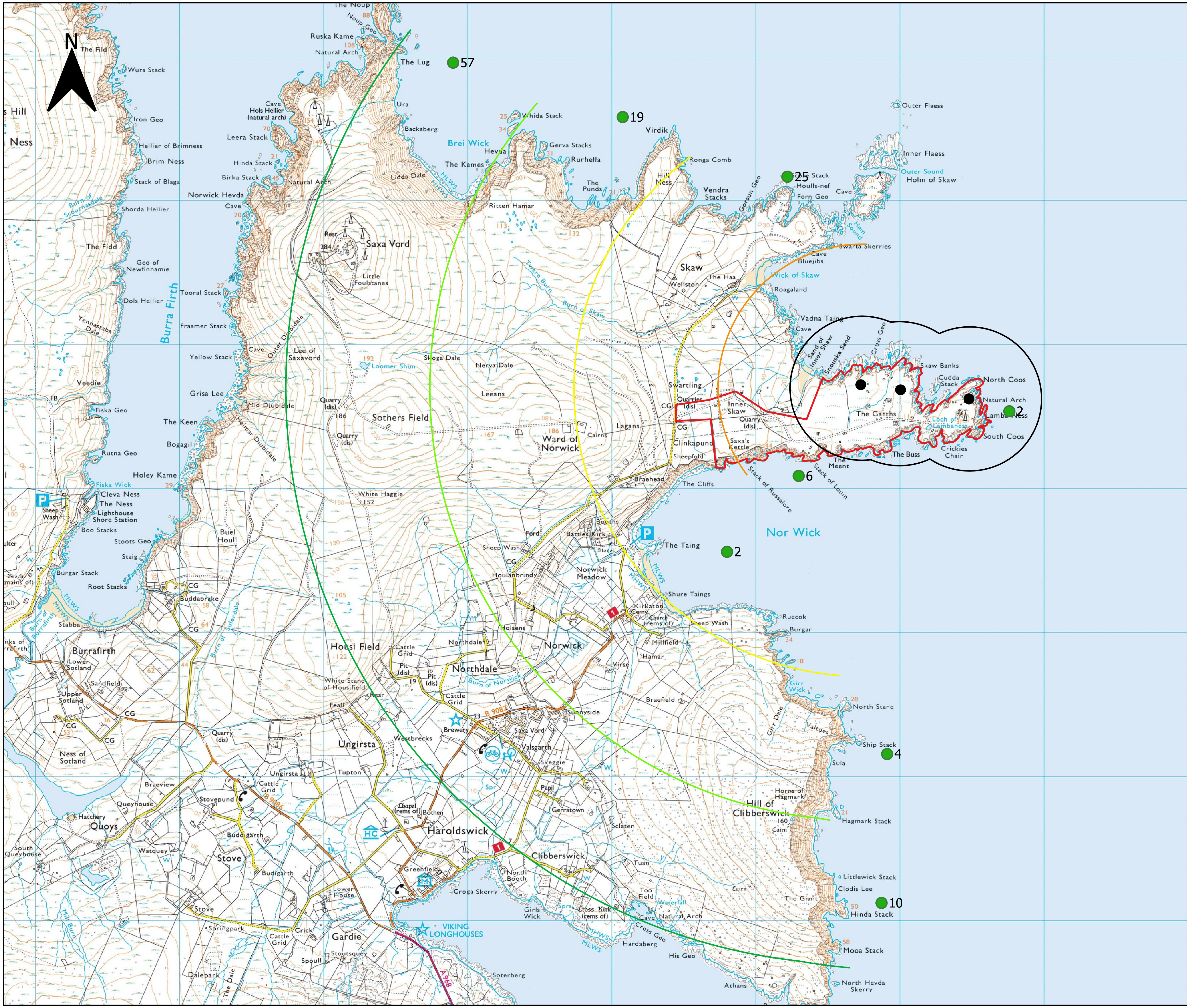
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.8
Breeding razorbill within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.9 Breeding Puffins within EZI



Project Number: 3148

KEY

- Puffin individuals
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.9
Breeding puffin within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Chapter 5 SaxaVord Spaceport Drawing 5.10 Breeding Ringed Plover within EZI

KEY

Ringed plover territory centre

- 2018
- 2019
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.10
Breeding ringed plover within the Study Area

Date: 16/11/2021	Drawn by: K.M.	Checked by: P.C.	Version: Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.11 Breeding Ringed Plover within the Proposed Project Boundary

KEY

Ringed plover territory centre

- 2018
- 2019

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

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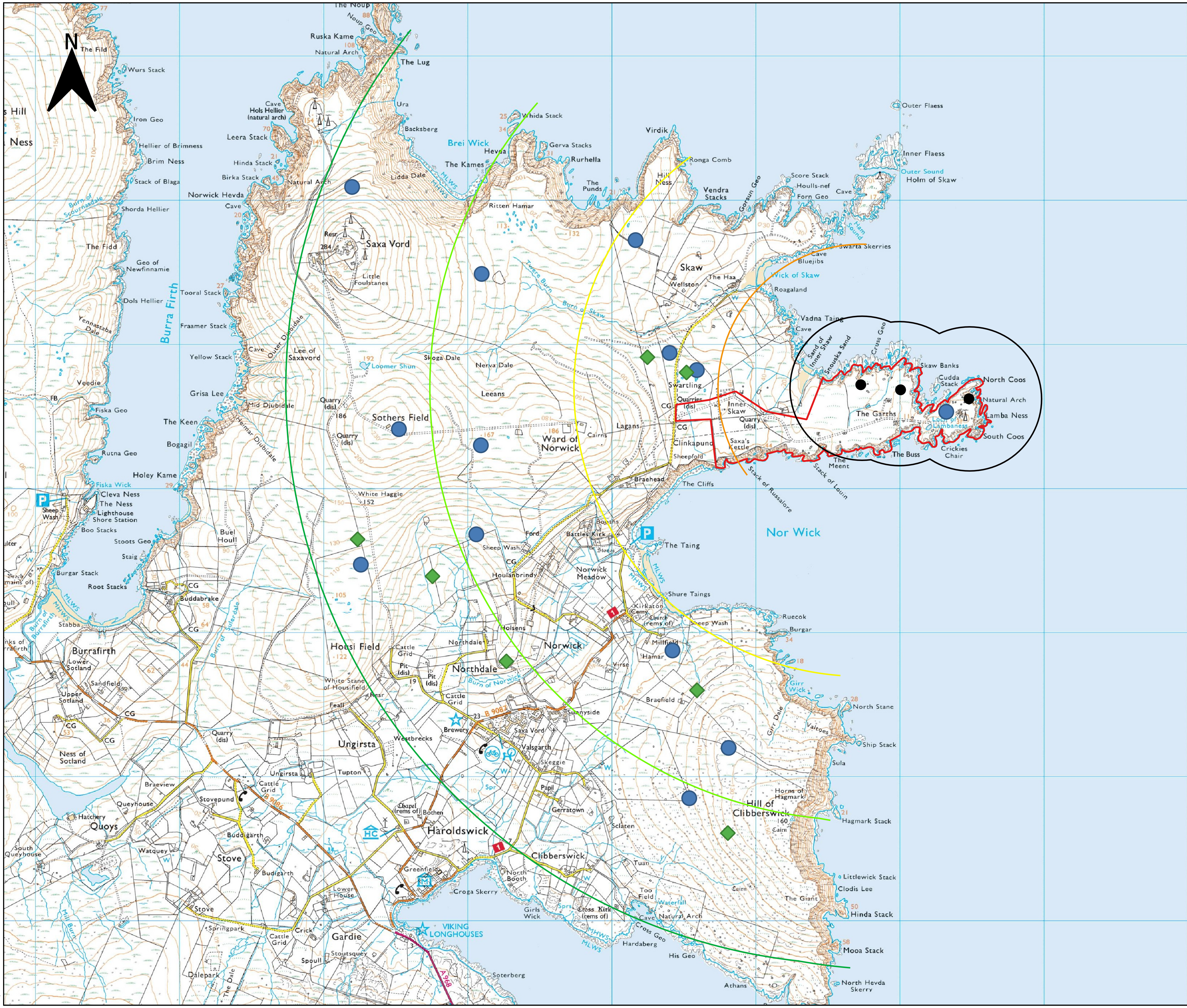
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.11
Breeding ringed plover within the Proposed Project Boundary

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.12 Breeding Golden Plover within EZI



KEY

Golden plover territory centre

- 2018
- 2019
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effectst

Drawing 5.12
Breeding golden plover within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.13 Breeding Golden Plover within Proposed Project Boundary

KEY

Golden plover territory centre

- 2018
- 2019

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

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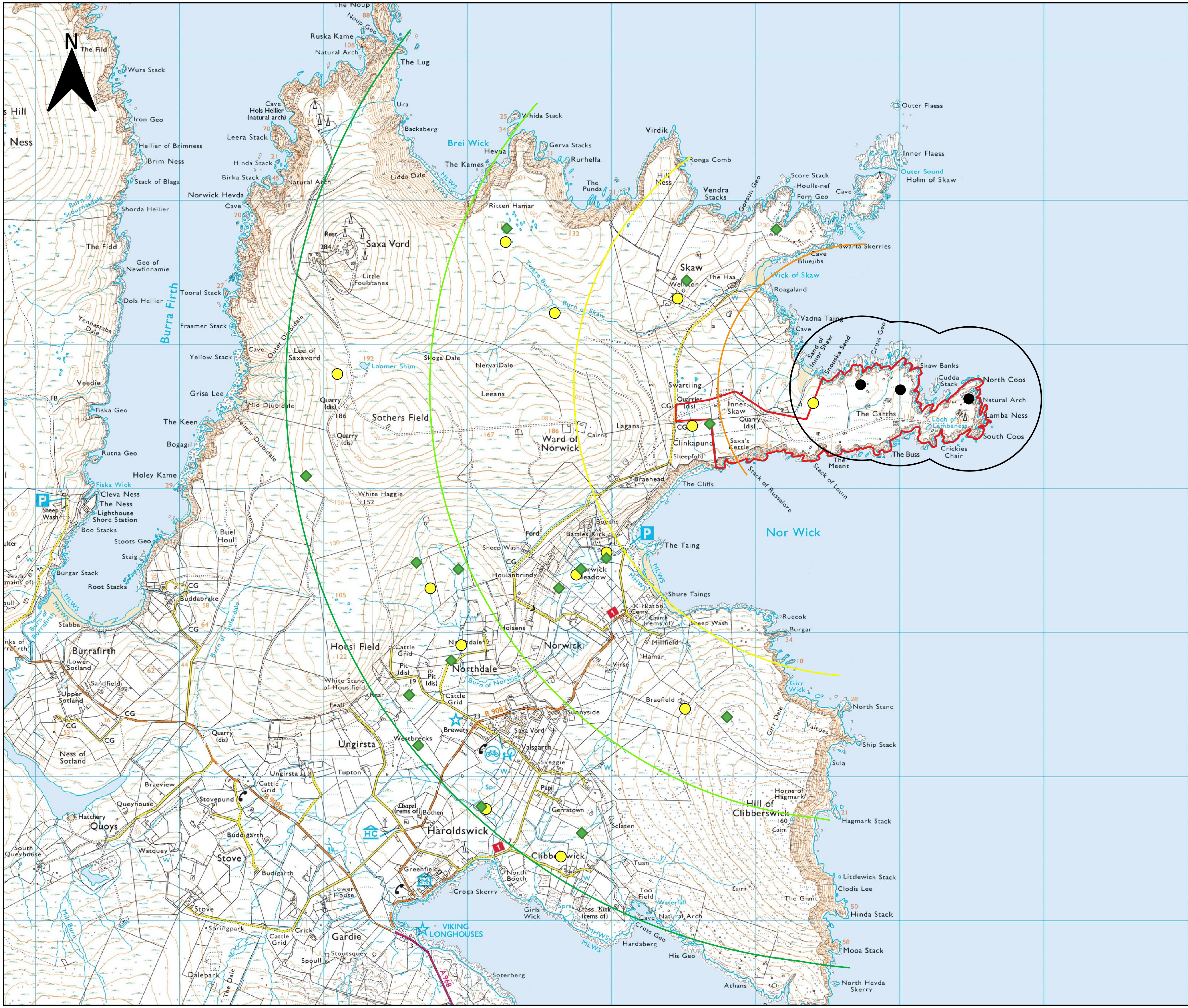
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.13
Breeding golden plover within the Proposed Project Boundary

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.14 Breeding Curlew within EZI



KEY

Curlew territory centre

- 2019
- 2018
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.14
Breeding curlew within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.15 Breeding Curlew within Proposed Project Boundary

KEY

Curlew territory centre

2019

2018

Spaceport design layout

Infrastructure/building

Fenced launch pad area

Road

Construction compound

Temporary construction compound

Track to wildlife hide

Wildlife hide

Launch pad

Fence

Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.15
Breeding curlew within the Proposed Project Boundary

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.16 Breeding Dunlin within EZI

KEY

- Dunlin territory centre
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.16
Breeding dunlin within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.17 Breeding Dunlin within Proposed Project Boundary

KEY

Dunlin territory centre

Spaceport design layout

Infrastructure/building

Fenced launch pad area

Road

Construction compound

Temporary construction compound

Track to wildlife hide

Wildlife hide

Launch pad

Fence

Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

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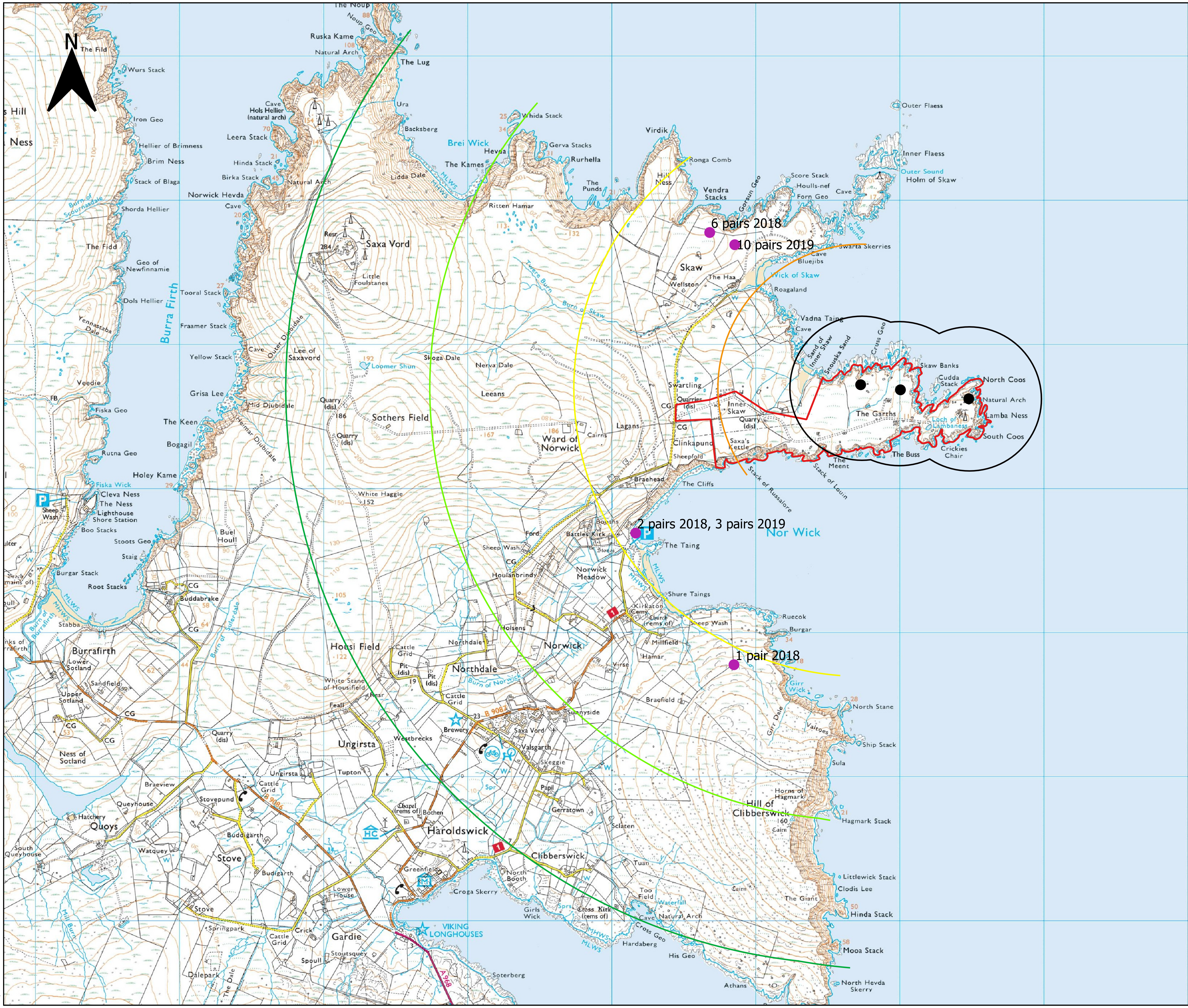
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.17
Breeding dunlin within the Proposed Project Boundary

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.18 Breeding Arctic Tern within EZI



KEY

- Arctic tern nests
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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Assessment of Environmental Effects

Drawing 5.18
Breeding arctic tern within the Study Area

Date: 16/11/2021	Drawn by: K.M.	Checked by: P.C.	Version: Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.19 Breeding Arctic Skua within EZI

KEY

Arctic skua territory centre

- 1 pair 2018 and 19 2 pair 2020
- 2018
- 2018 & 2019
- 2019
- 2020
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 | 500 | 1,000 m

Scale 1:25,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.19
Breeding arctic skua within the Study Area

Date: 16/11/2021	Drawn by: K.M.	Checked by: P.C.	Version: Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.20 Breeding Arctic Skua within Proposed Project Boundary

KEY

Arctic skua territory centre

- 1 pair 2018 and 19 2 pair 2020
- 2018
- 2018 & 2019
- 2019
- 2020

Spaceport design layout

- Infrastructure/building
- Fenced launch pad area
- Road
- Construction compound
- Temporary construction compound
- Track to wildlife hide
- Wildlife hide
- Launch pad
- Fence
- Proposed Project Site Boundary

0 200 400 m

Scale 1:15,000 @ A3

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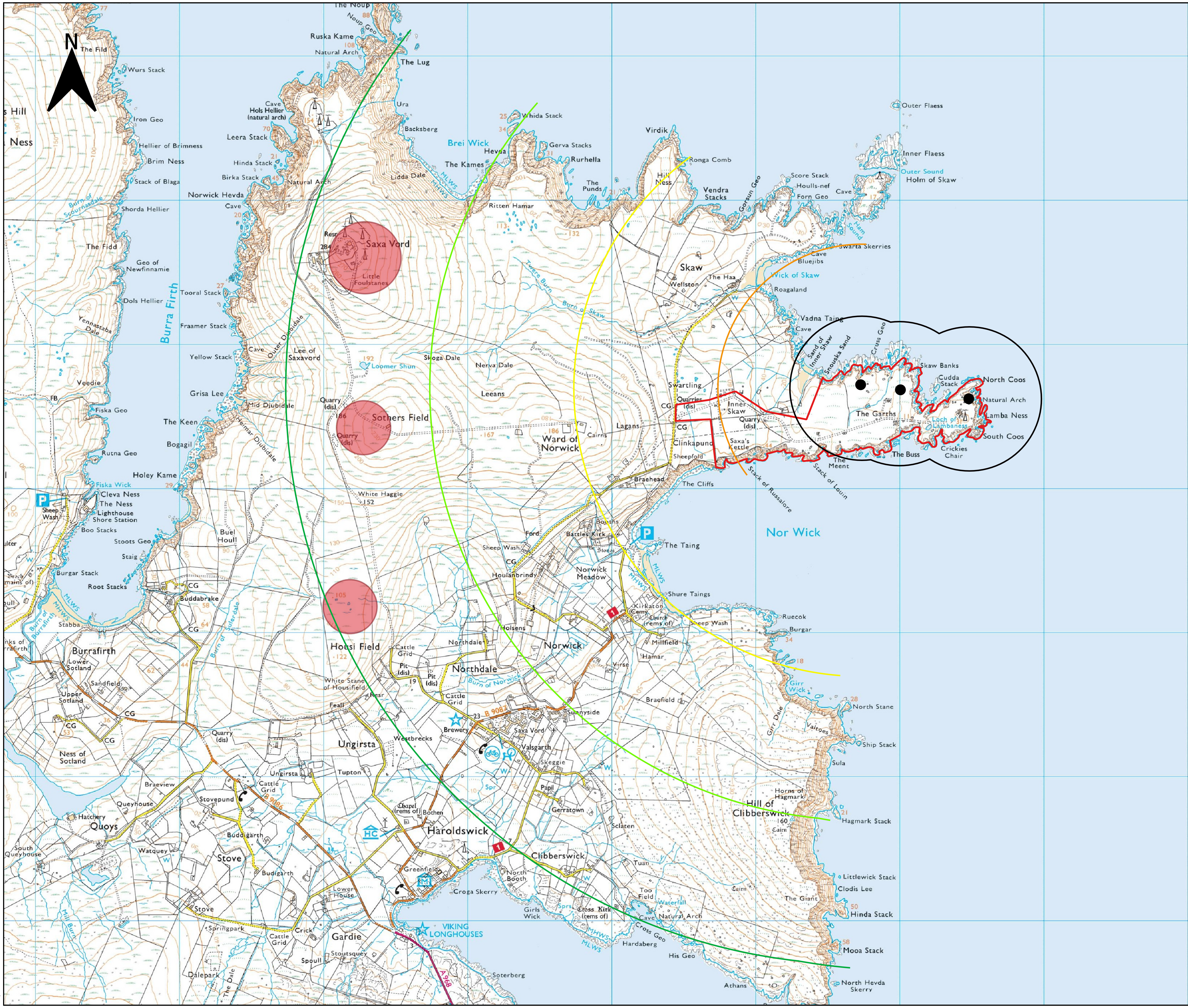
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.20
Breeding arctic skua within the Proposed Project Boundary

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 6

Project Number: 3148

Chapter 5 SaxaVord Spaceport Drawing 5.21 Breeding Great Skua within EZI



KEY

- Main great skua breeding areas
- Proposed Project Site Boundary
- Launch pad
- 0.5km buffer launch pads
- 1km buffer launch pads
- 2km buffer launch pads
- 3km buffer launch pads
- 4km buffer launch pads

0 500 1,000 m

Scale 1:25,000 @ A3

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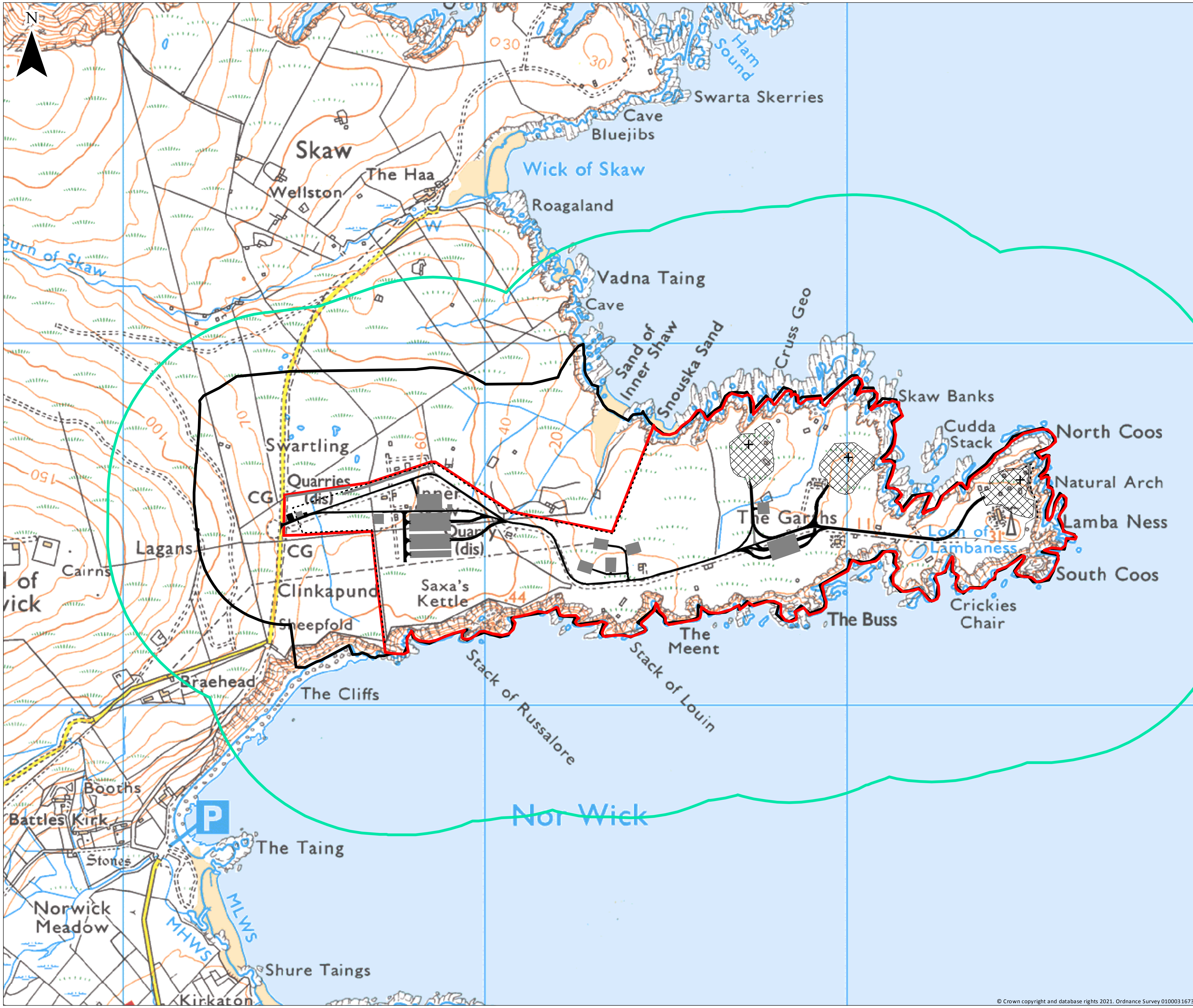
Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 5.21
Breeding great skua within the Study Area

Date:	Drawn by:	Checked by:	Version:
16/11/2021	K.M.	P.C.	Rev. 7

Project Number: 3148

Chapter 6 SaxaVord Spaceport Drawing 6.1 Ecology Study Area



KEY

- Launch Pad
- Fence
- Fenced Launch Pad Area
- Building/Infrastructure
- Road
- Proposed Project Site Boundary
- Habitat Study Area, 250m buffer
- Otter Study Area, 500m buffer

0 250 500 m

Scale 1:10,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

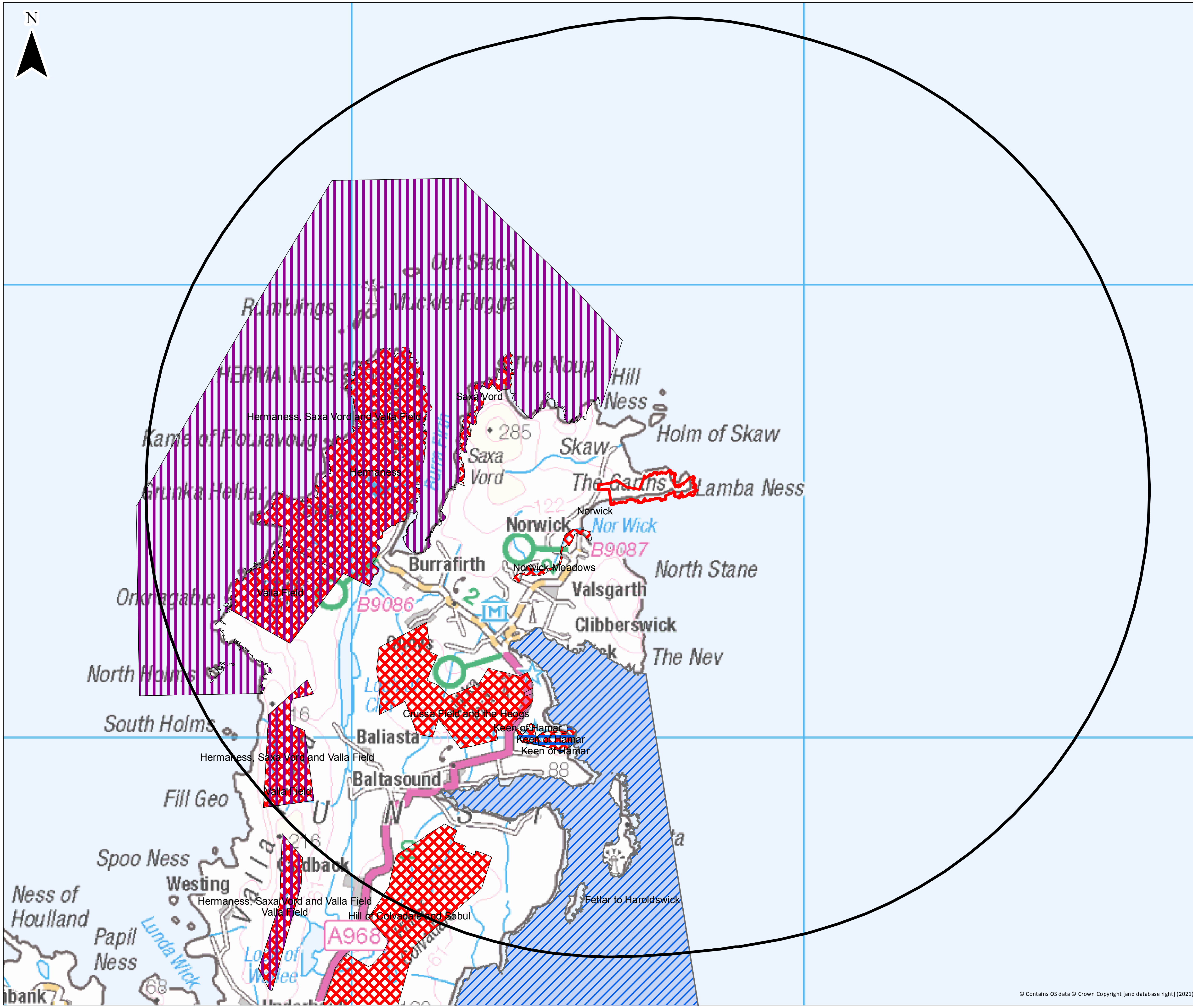
Drawing 6.1

Study Area

Date: 16/11/2021	Drawn by: KM	Checked by: RF	Version: Draft/V1

Project Number: 3148

Chapter 6 SaxaVord Spaceport Drawing 6.2 Designated Sites



KEY

- Proposed Project Boundary
- 10km buffer
- Marine Protected Area
- Special Areas of Conservation
- Special Protection Areas
- Sites of Special Scientific Interest

0 2 4 km

Scale 1:80,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

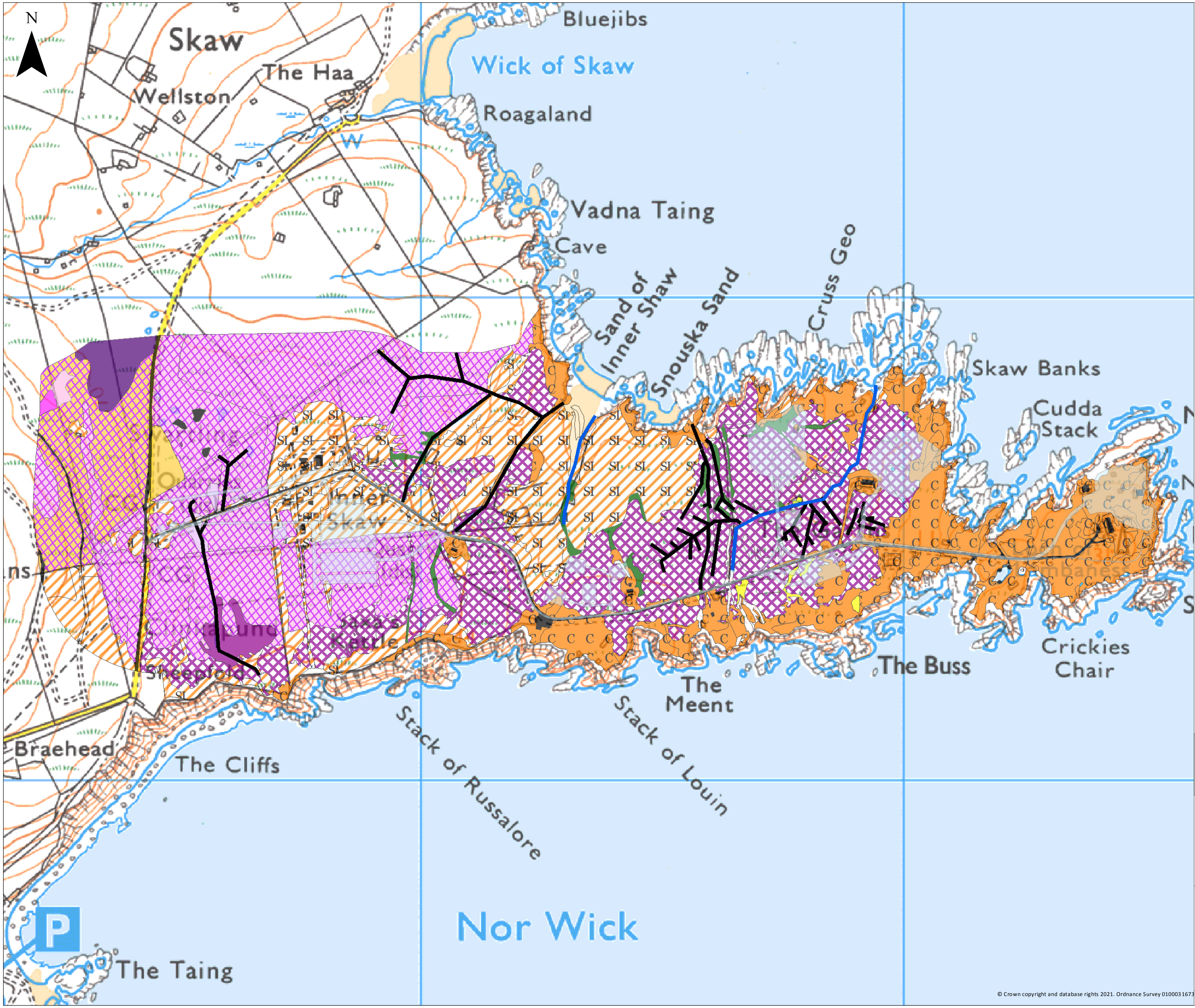
Drawing 6.2

Designated Sites

Date: 16/11/2021	Drawn by: KM	Checked by: RF	Version: Draft/V1

Project Number: 3148

Chapter 6 SaxaVord Spaceport Drawing 6.3 Phase 1 Habitat Study Area



Infrastructure
Drain
Watercourse
Unimproved acid grassland
Semi-improved acid grassland
Neutral grassland
Blanket bog
Wet modified bog
Wet modified bog/wet heath
Blanket bog/bare peat
Wet modified bog/wet heath/bare peat
Wet modified bog/wet heath/acid flush
Dry dwarf shrub heath
Fen
Acid flush
Wet modified bog/wet heath/dry heath
Bare peat
Marginal vegetaion
Standing water
Saltmarsh
Sand dunes
Coastal grassland
Buildings and roads
Bare ground

0 200 400 m

Scale 1:7,500 @ A3

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Assessment of Environmental Effects

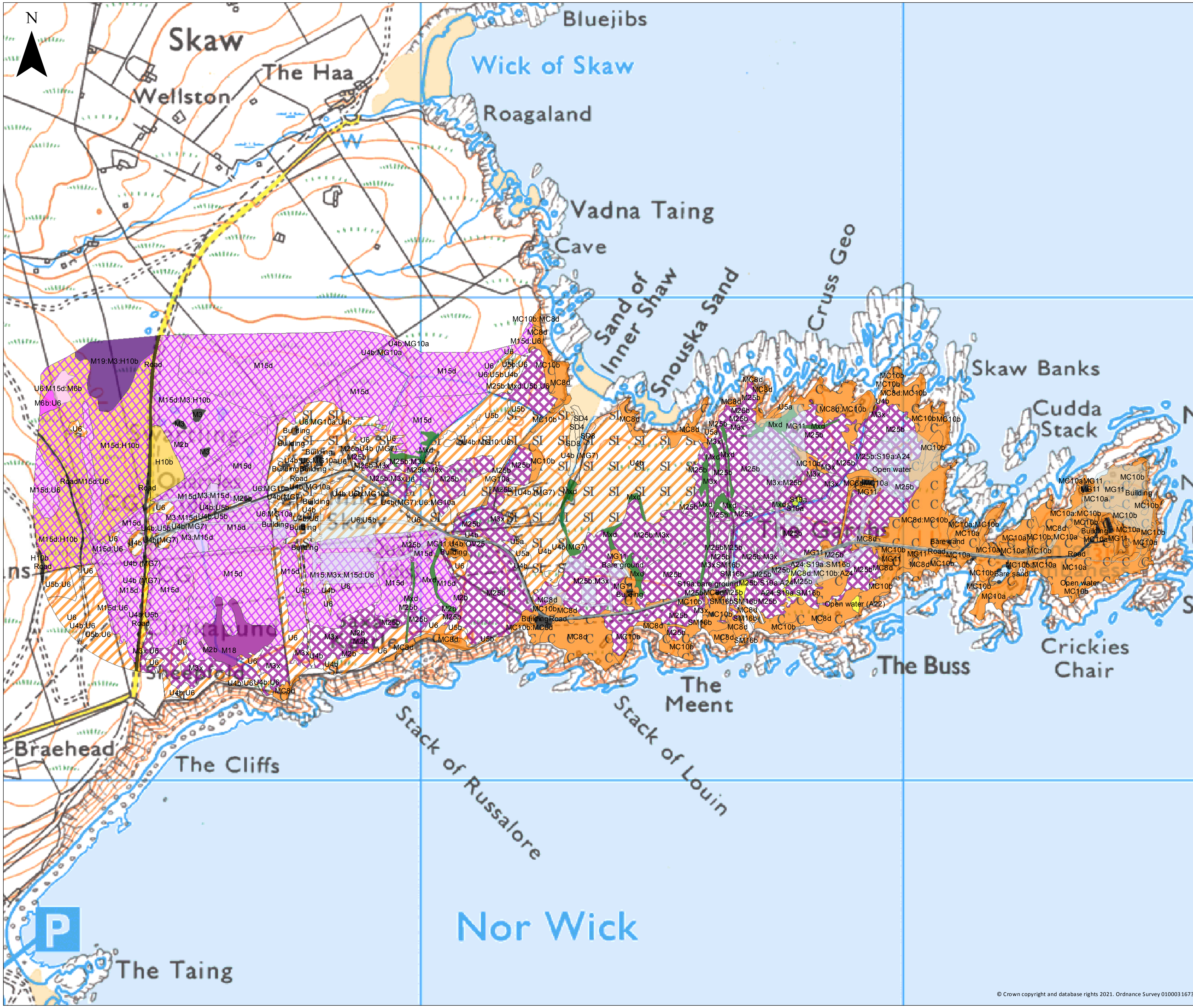
Drawing 6.3

Phase 1 Habitats

Date:	Drawn by:	Checked by:	Version:
16/11/2021	KM	RF	Draft/V1

Project Number: 3148

Chapter 6 SaxaVord Spaceport Drawing 6.4 NVC Habitat Study Area



KEY

- Infrastructure
- Unimproved acid grassland, U5, U6
- Semi-improved acid grassland, U4
- Neutral grassland, MG10
- Blanket bog, M2b, M18
- Wet modified bog, M25, M3x
- Wet modified bog/wet heath, M15
- Blanket bog/bare peat, M19/M3
- Wet modified bog/wet heath/bare peat, M15d/M3
- Wet modified bog/wet heath/acid flush, M15d/M6
- Dry dwarf shrub heath, H10
- Fen, Mxd
- Acid flush, M6
- Wet modified bog/wet heath/dry heath, M15d/H10b
- Bare peat, M3
- Marginal vegetaion, S19, A24, A22
- Standing water
- Saltmarsh, SM16
- Sand dunes, SD4, SD8
- Coastal grassland, MC8, MC10, MG11
- Buildings and roads
- Bare ground

0 200 400 m

Scale 1:7,500 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

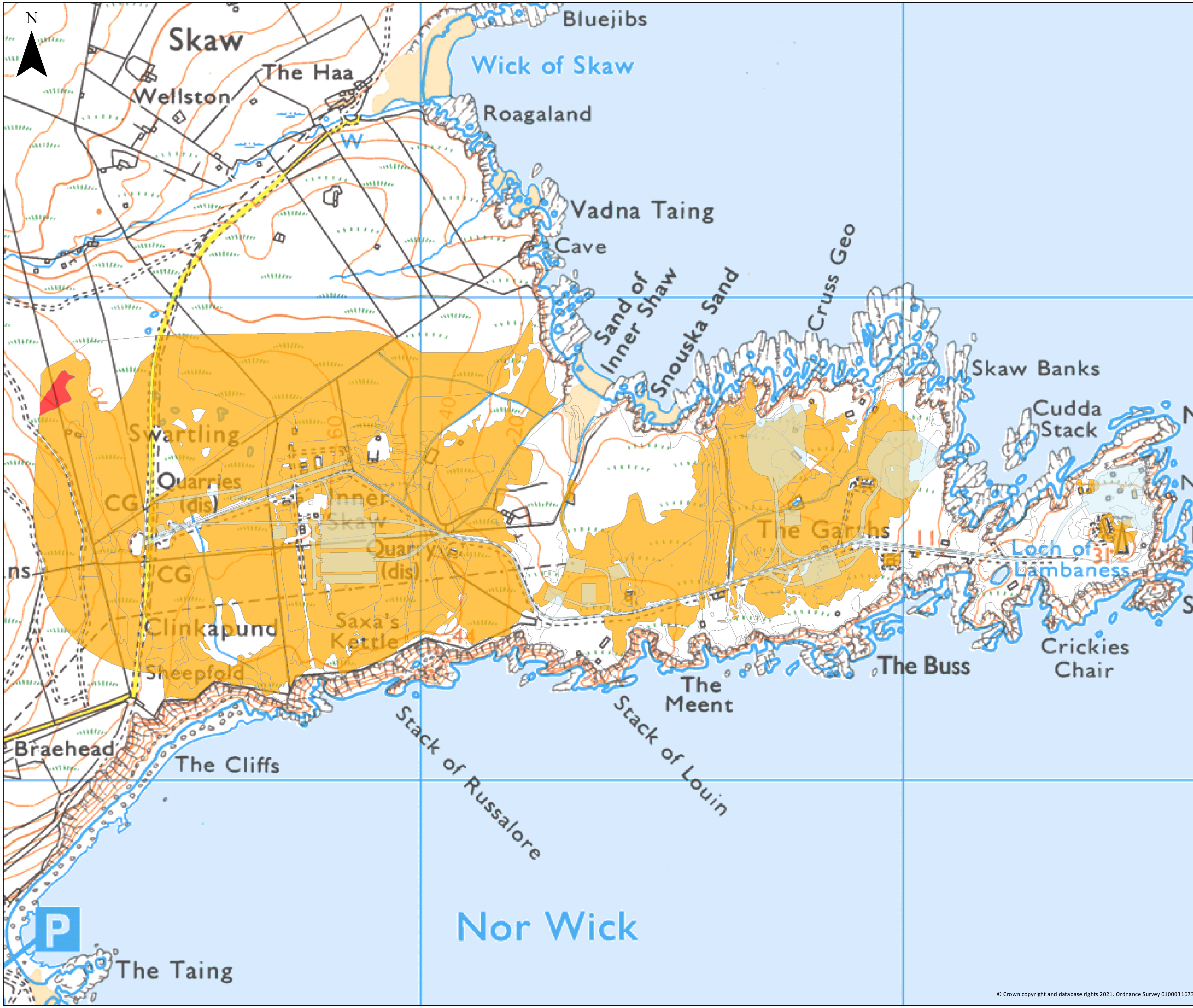
Drawing 6.4

NVC

Date:	Drawn by:	Checked by:	Version:
16/11/2021	KM	RF	Draft/V1

Project Number: 3148

Chapter 6 SaxaVord Spaceport Drawing 6.5 Potential Ground Water Dependant Terrestrial Ecosystems



KEY

- Infrastucture
- Potentially high GWDTE
- Potentially moderate GWDTE
- Not a GWDTE

0 200 400 m

Scale 1:7,500 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

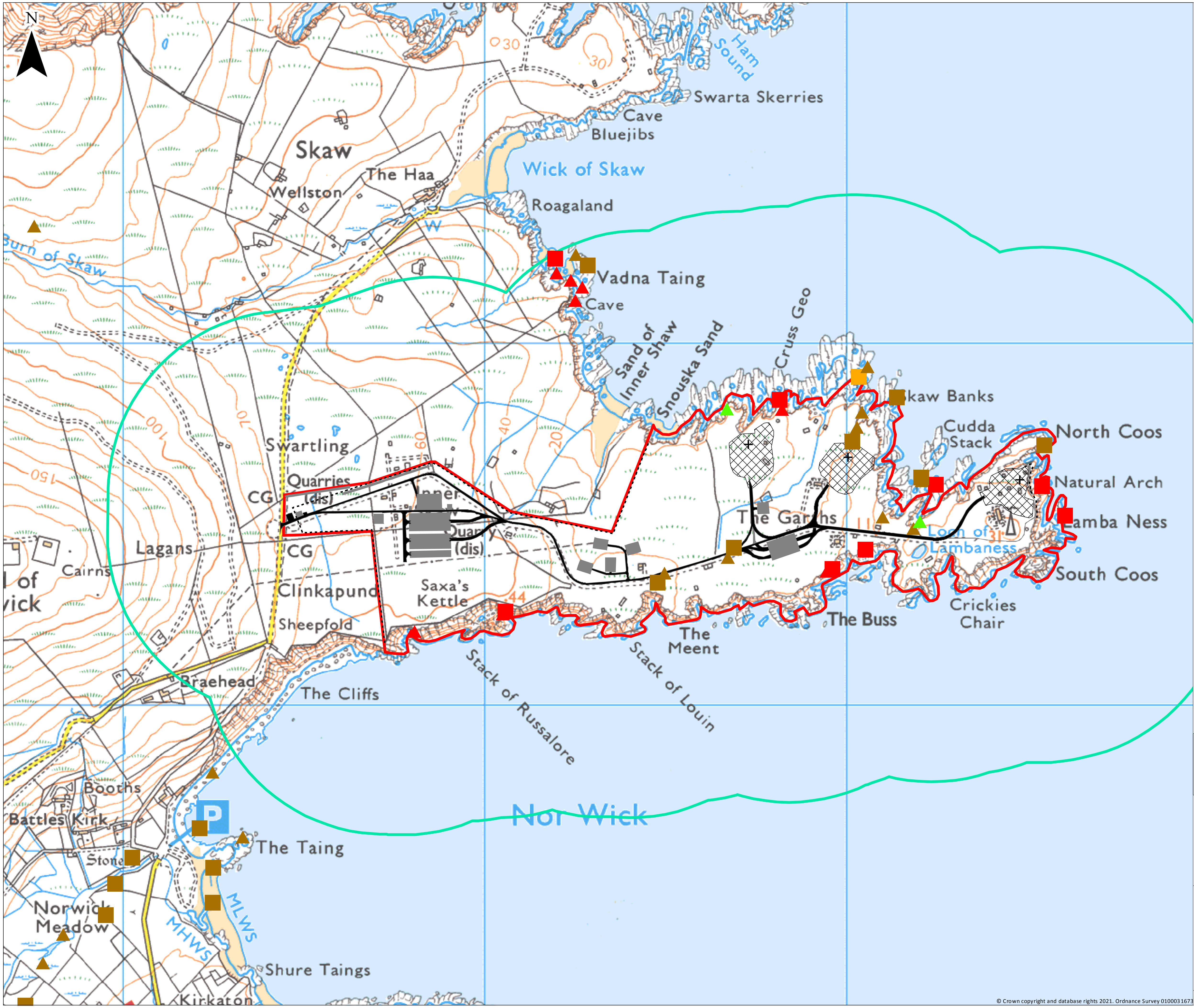
Drawing 6.5

Potential GWDTE

Date:	Drawn by:	Checked by:	Version:
16/11/2021	KM	RF	Draft/V1

Project Number: 3148

Chapter 6 SaxaVord Spaceport Drawing 6.6 Otter Signs 2018



KEY

- Holts, spring 2018
- Spraints and prints, spring 2018
- Run, spring 2018
- Holt, autumn 2018
- Lay up, autumn 2018
- Spraints and prints, autumn 2018
- Launch Pad
- Fence
- Fenced Launch Pad Area
- Building/Infrastructure
- Road
- Proposed Project Site Boundary
- Otter Study Area, 500m buffer

0 250 500 m

Scale 1:10,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

Drawing 6.6

Otter Signs

Date: 16/11/2021	Drawn by: KM	Checked by: RF	Version: Draft/V1

Project Number: 3148

Chapter 6 SaxaVord Spaceport Drawing 6.7 Otter Signs 2020

KEY

- Holt
- Lay up
- Spraints and prints
- Run
- Launch Pad
- Fence
- Fenced Launch Pad Area
- Building/Infrastructure
- Road
- Proposed Project Site Boundary

0 250 500 m

Scale 1:10,000 @ A3

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Saxa Vord Spaceport
Assessment of Environmental Effects

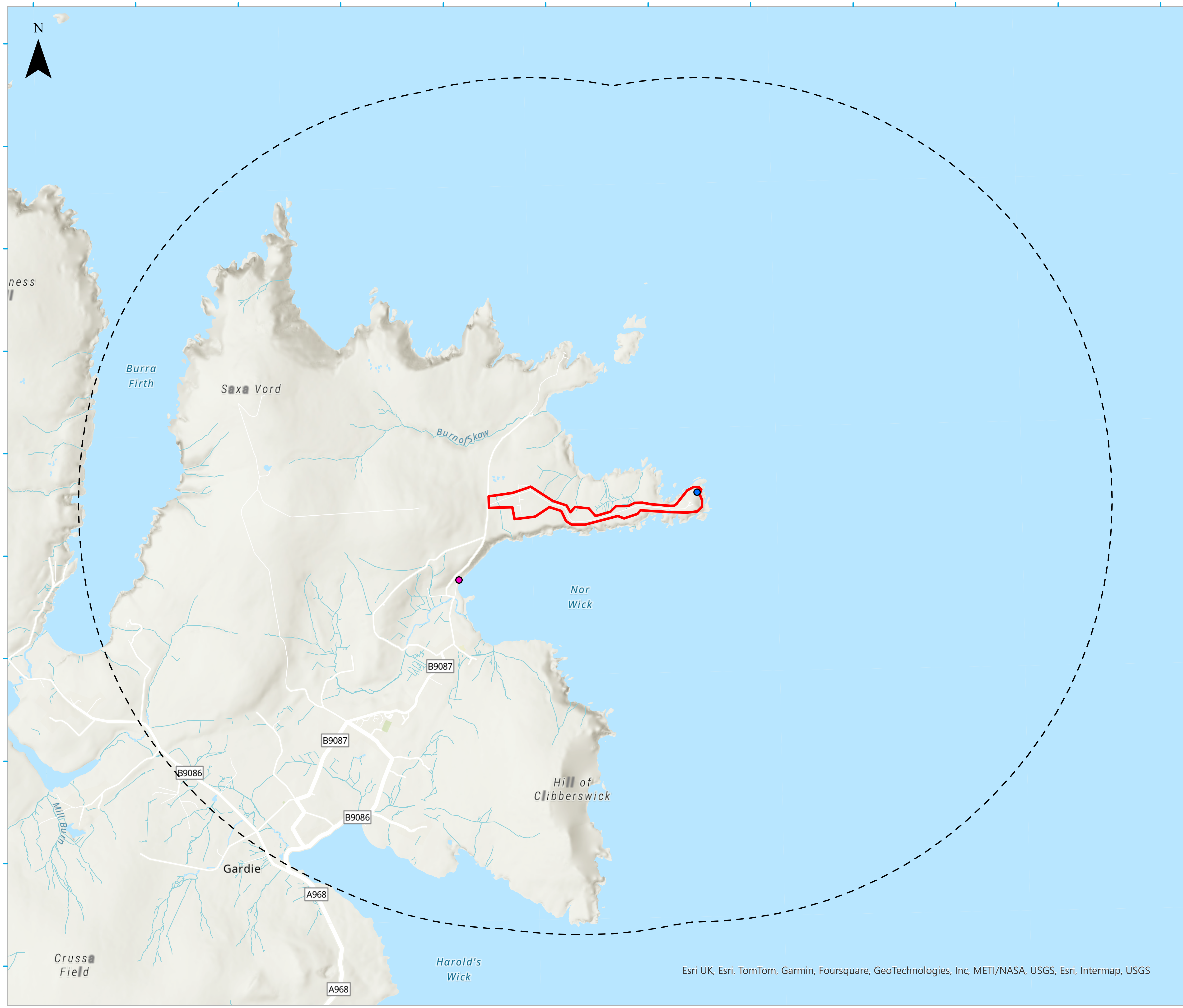
Drawing 6.7

Otter Signs

Date:	Drawn by:	Checked by:	Version:
16/11/2021	KM	RF	Draft/V1

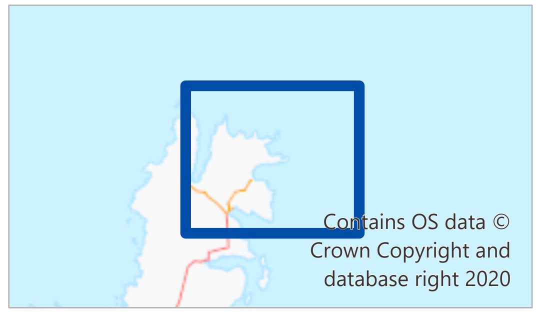
Project Number: 3148

Chapter 7 Drawing 7.1 Project Location and Receptors



KEY

- Proposed Project Boundary
- 4km Environmental Zone of Influence Buffer
- Launch Pad 3
- Receptor 1 - Banks Cottage

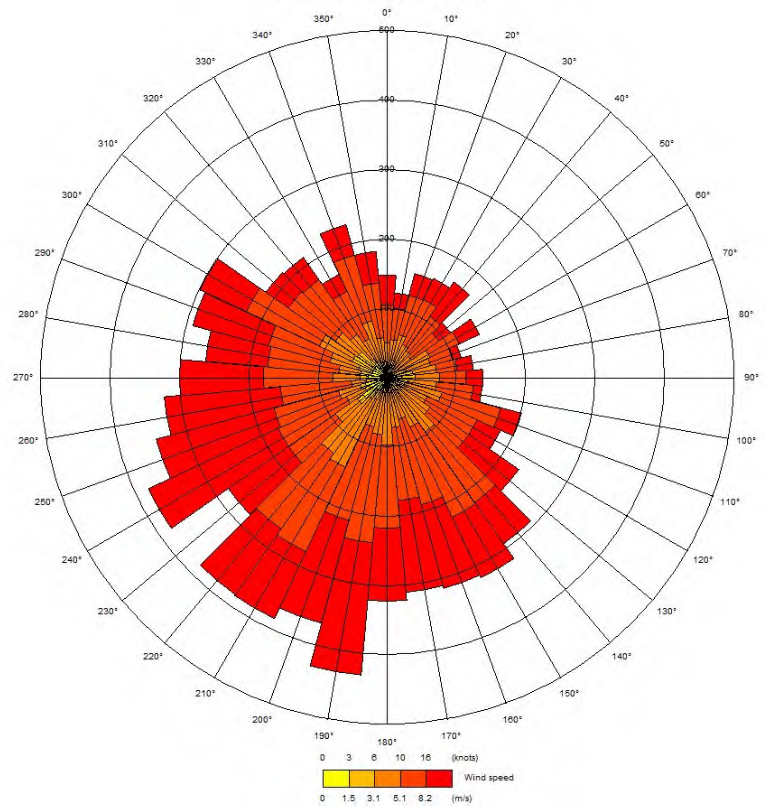


PRIME Saxavord
AEE
Figure 7.1
Project Boundary, Launch Pad and Receptor Locations

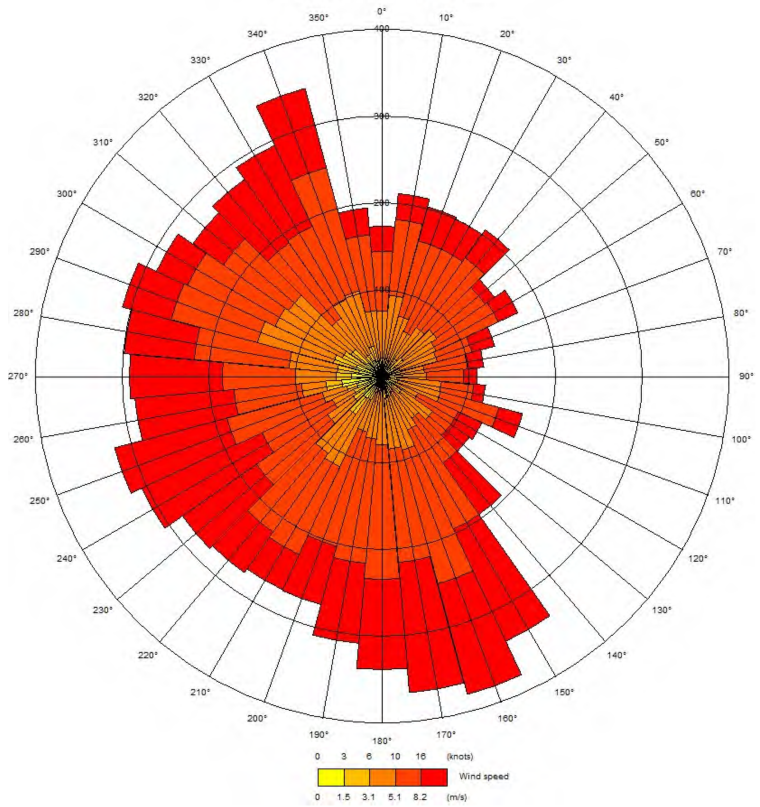
Scale	Date
1:500,000 @ A3	JANUARY 2025

Chapter 7 Drawing 7.2 Baltasound Unst 2020 – 2024 Wind Roses

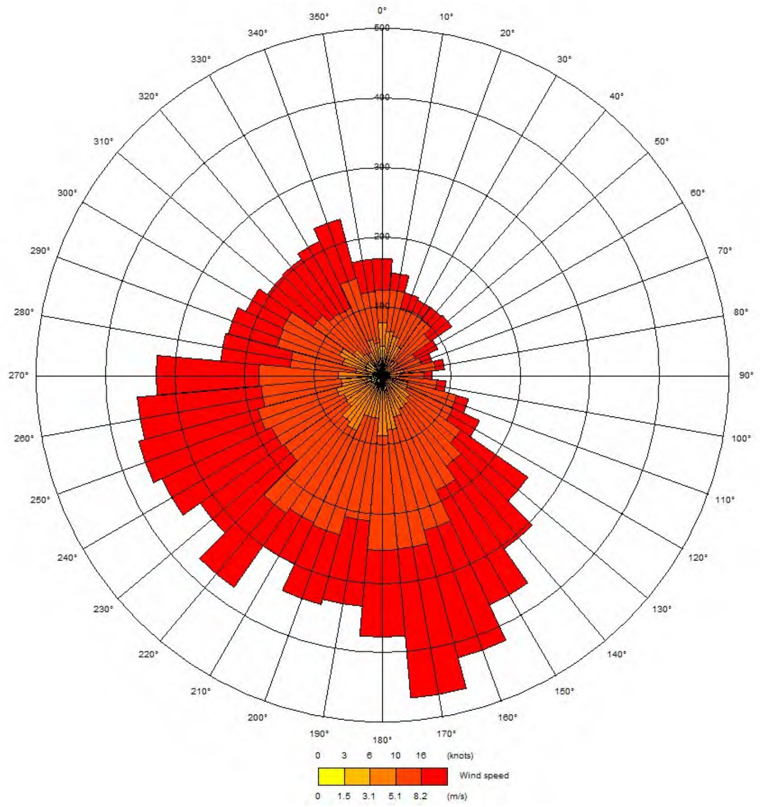
Baltasound Wind Rose 2020



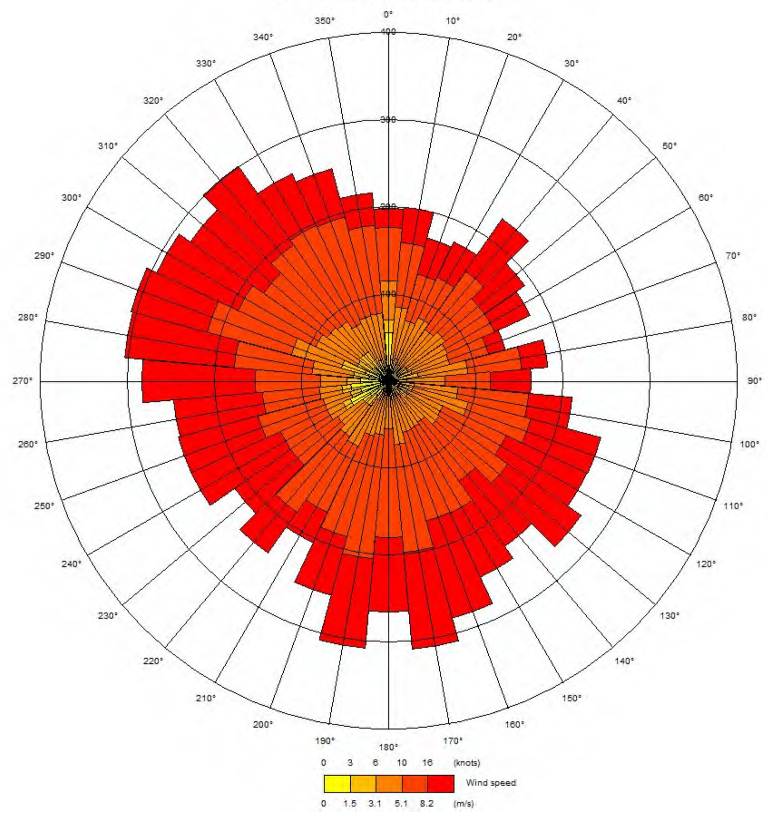
Baltasound Wind Rose 2021



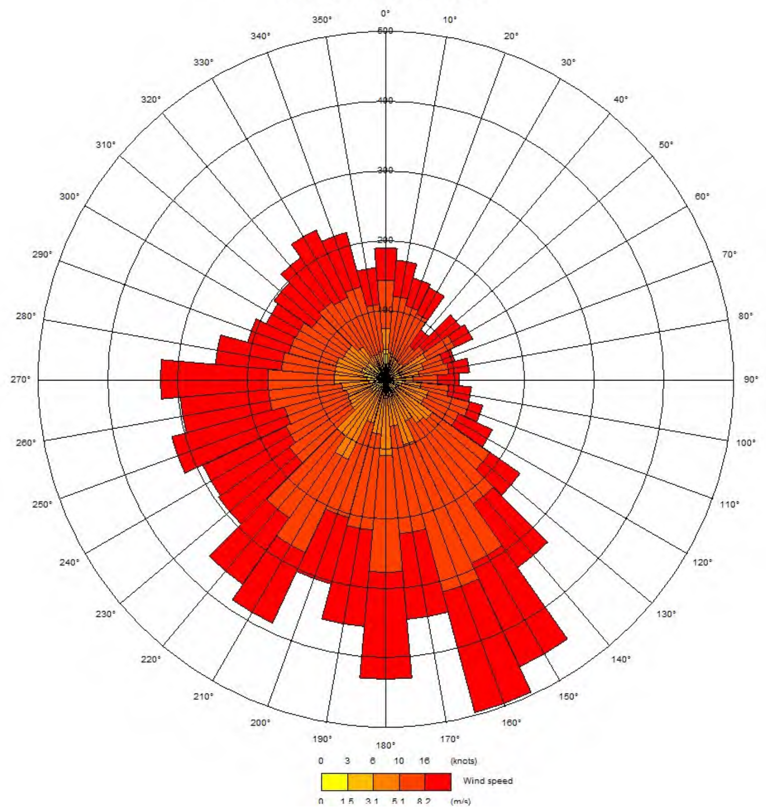
Baltasound Wind Rose 2022



Baltasound Wind Rose 2023



Baltasound Wind Rose 2024



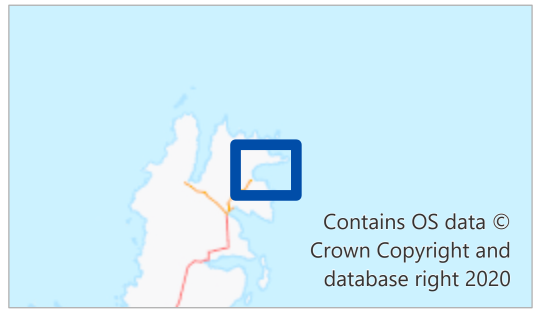
aurora ORBEX SLR

Orbex PRIME Saxavord
Assessment of Environmental Effects

Figure 7.2
Baltasound, Unst
Meteorological Data Wind Rose
2020 - 2024

Date:	Lead:	Review:	Version:
27/01/2025	ER	AD	1.0

Chapter 7 Drawing 7.3 CO Contour Plots 60 – 240s



aurora

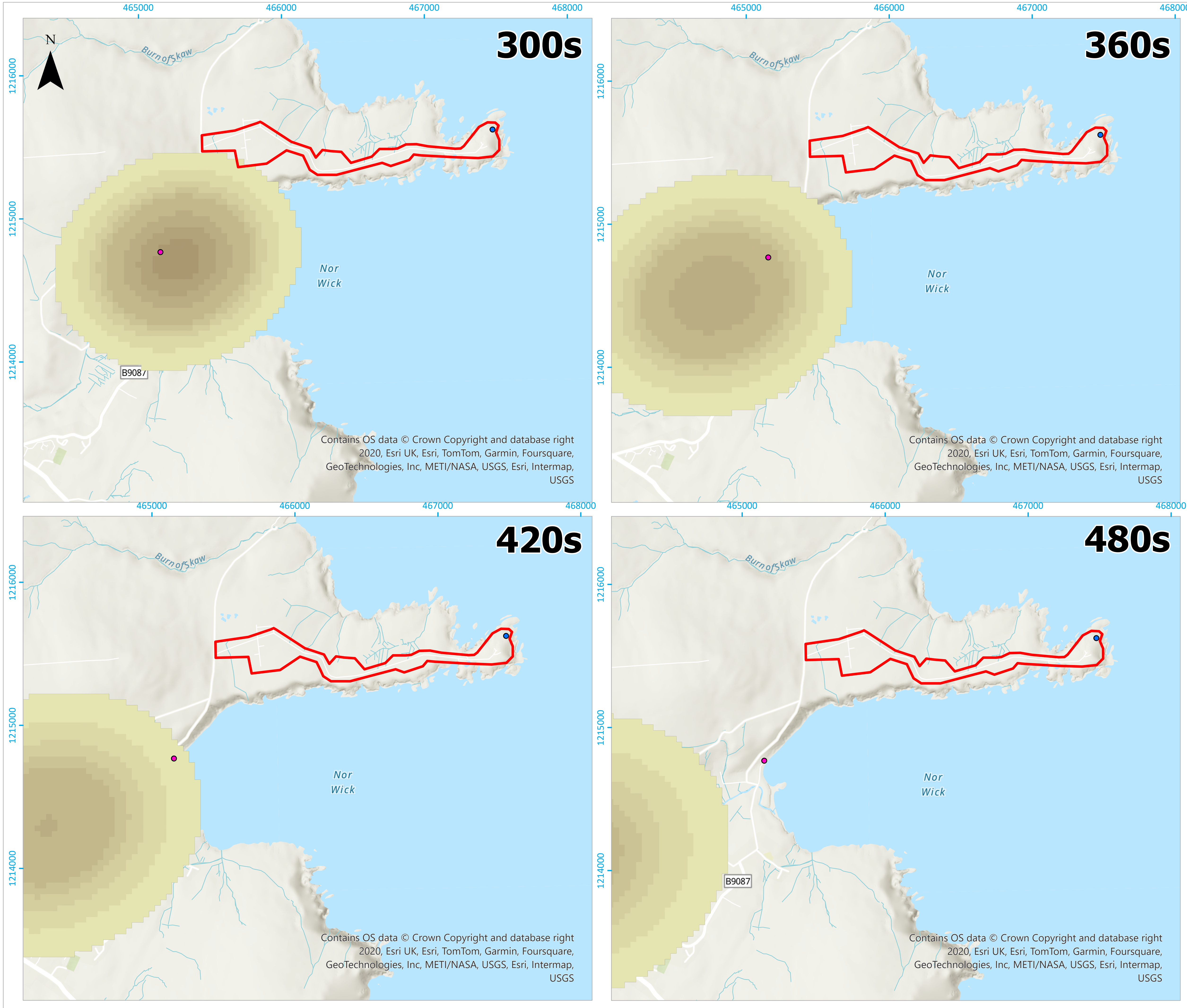
ORBEX

SLR

PRIME Saxavord
AEE
Figure 7.3
CO Contour Plots 60s - 240s

Scale	Date
1:500,000 @ A3	JANUARY 2025

Chapter 7 Drawing 7.4 CO Contour Plots 300 – 480s

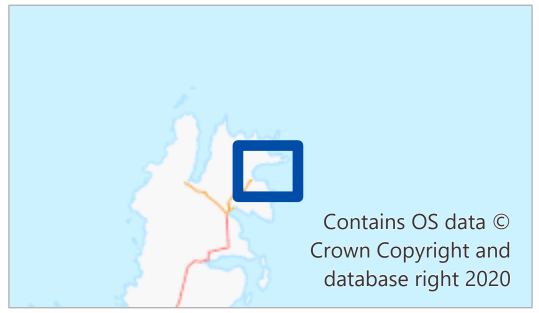


KEY

- Proposed Project Boundary
- Launch Pad 3
- Receptor 1 - Banks Cottage

CO Concentrations mg/m^3

0.05 - 0.1	4 - 5
0.1 - 0.25	5 - 6
0.25 - 0.5	6- 7
0.5 - 0.75	7 - 8
0.75 - 1	8 - 9
1 - 2	9 - 10
2 - 3	> 10
3 - 4	



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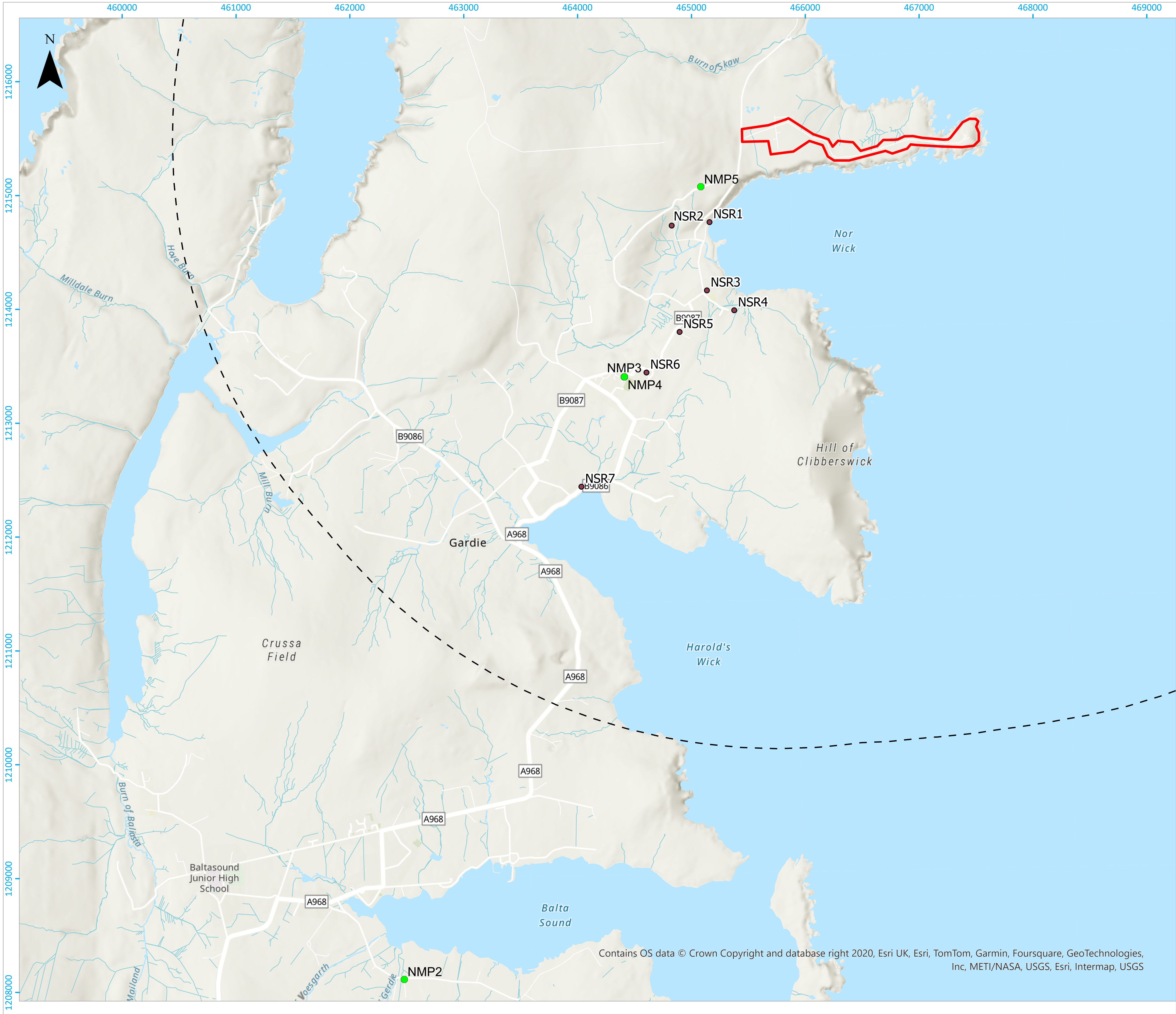
PRIME Saxavord
AEE
Figure 7.3
CO Contour Plots 300s - 480s

Scale 1:500,000 @ A3

Date JANUARY 2025

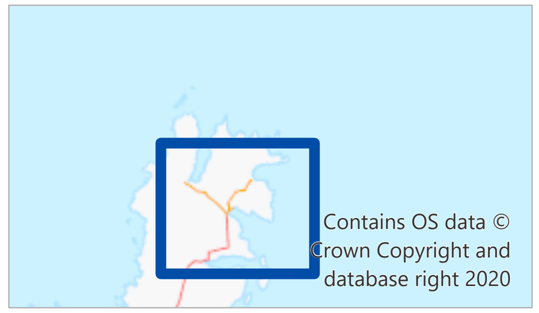
Chapter 8 Drawing 8.1 EZI, Noise Sensitive Receptors and Noise Monitoring Locations



KEY

- Proposed Project Boundary
- NSRs
- NMPs
- 5 km EZI

*NPM1 - Baltasound Airport - outside the EZI



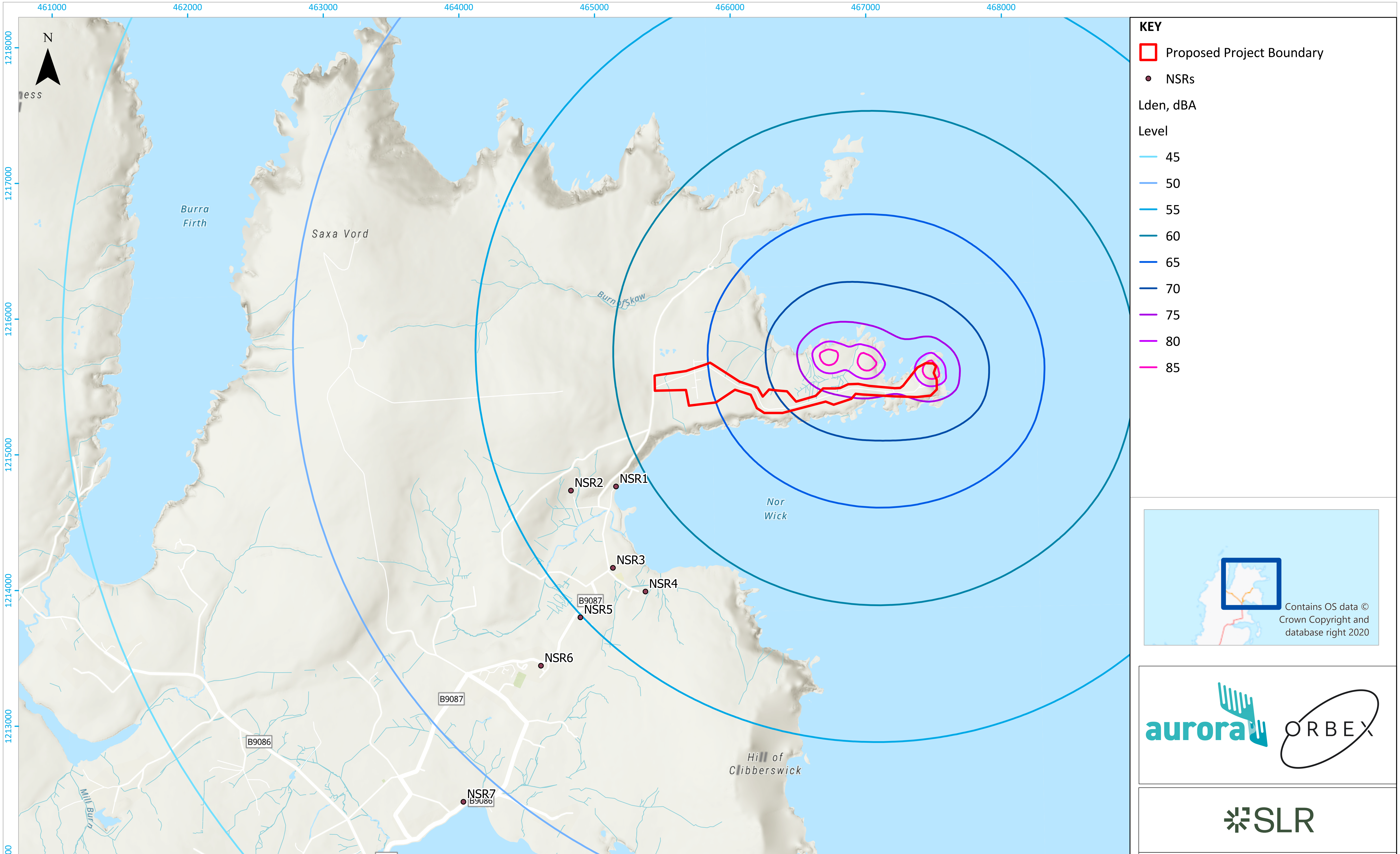
aurora ORBEX

SLR

Orbex PRIME SaxaVord AEE / 413.057914.00001
Assessment of Environmental Effects
Drawing 8.1
EZI, NSRs and NMPs

Scale	Date
1:500,000 @ A3	JANUARY 2025

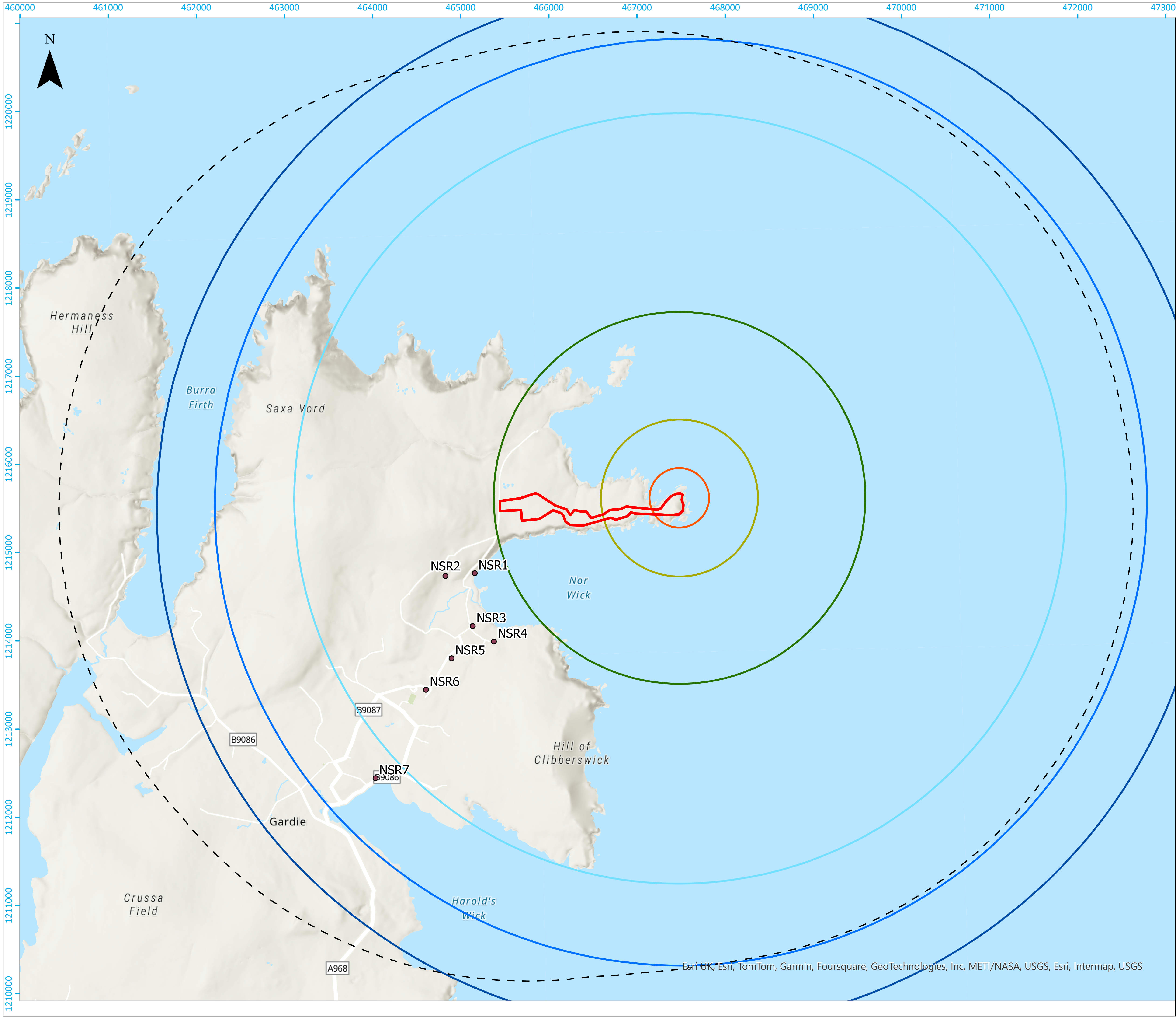
Chapter 8 Drawing 8.2 Lden Noise Contours



Orbex PRIME SaxaVord AEE / 413.057914.00001
Assessment of Environmental Effects
Drawing 8.2
Lden Noise Contours

Scale	Date
1:500,000 @ A3	JANUARY 2025

Chapter 8 Drawing 8.3 LAmax 1 second Noise Contours - Launch

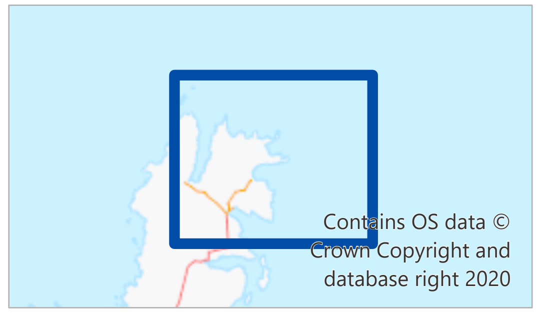


KEY

- Proposed Project Boundary
- NSRs
- 5 km buffer

Pad 3 Launch LAmax, dBA

- 85
- 87
- 90
- 100
- 110
- 120



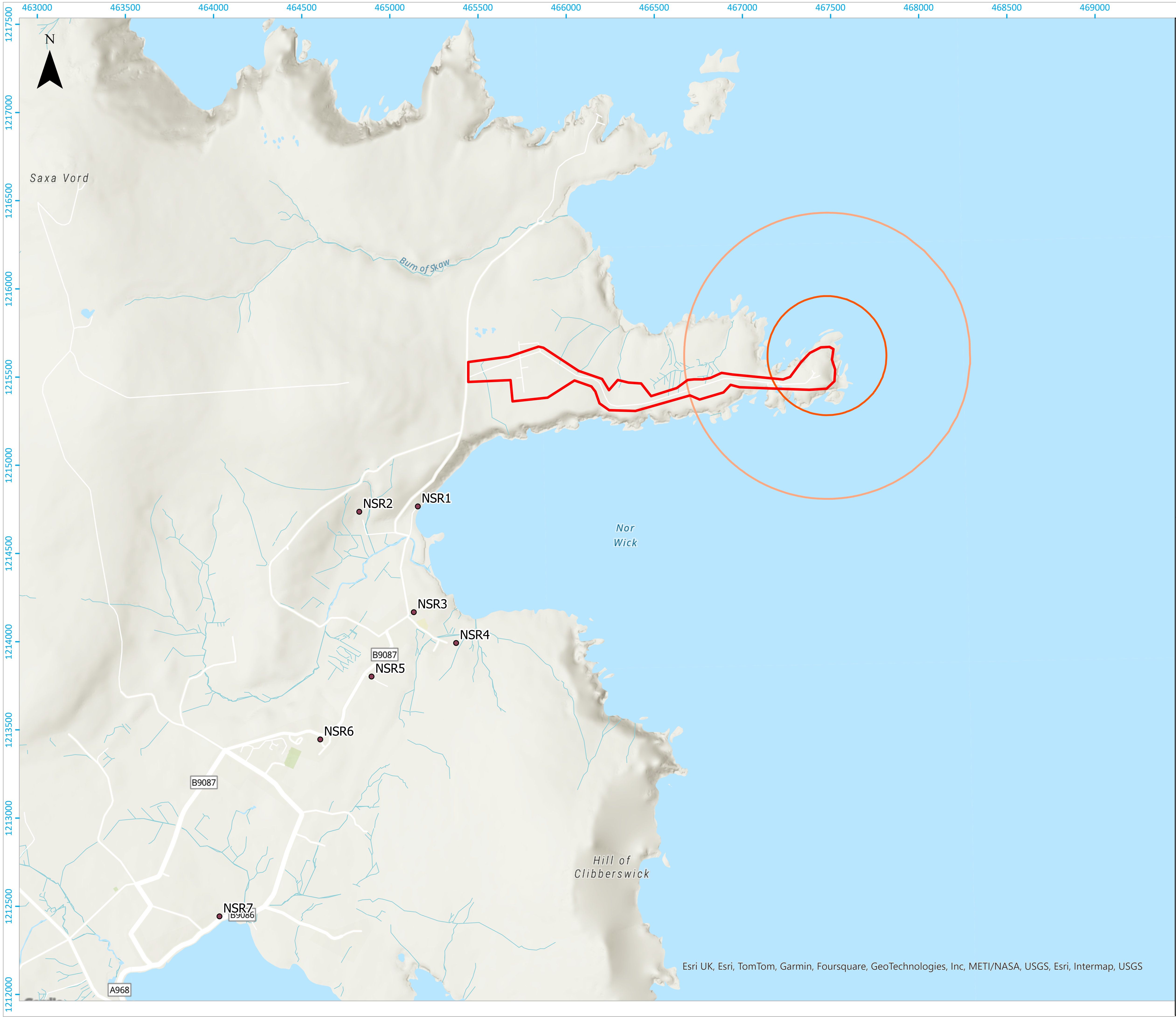
aurora ORBEX

SLR

Orbex PRIME SaxaVord AEE / 413.057914.00001
Assessment of Environmental Effects
Drawing 8.3 (Pad 3)
LAmax,1sec noise contours - launches

Scale	Date
1:500,000 @ A3	FEBRUARY 2025

Chapter 8 Drawing 8.4 Predicted Unweighted LAmax Noise – Launch



KEY

Proposed Project Boundary

NSRs

Level

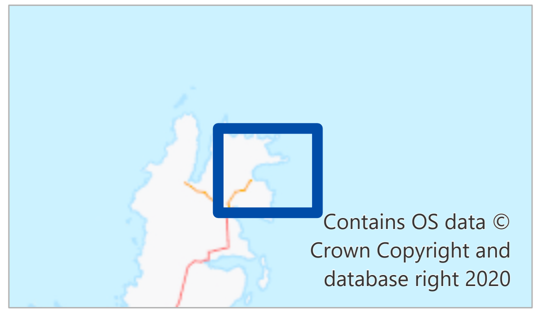
111

120

Proposed Project Boundary

Proposed Project Boundary

Proposed Project Boundary



aurora ORBEX

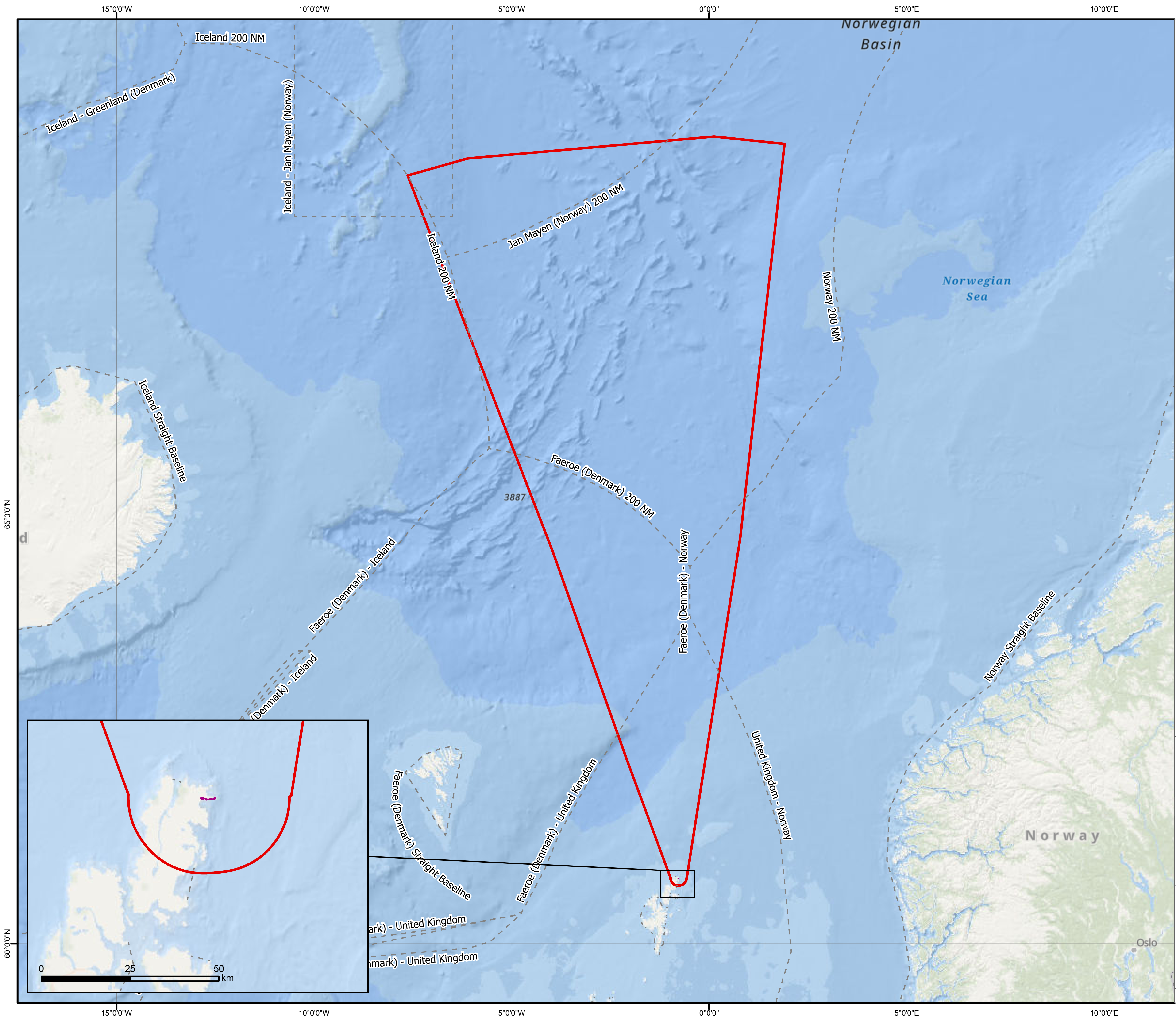
SLR

Orbex PRIME SaxaVord AEE /
413.057914.00001
Assessment of Environmental Effects
Drawing 8.4
Predicted Unweighted Lmax Noise
Contours for Launch Events

Scale	Date
1:500,000 @ A3	FEBRUARY 2025

Chapter 9 -

Chapter 10 Drawing 10.1 North Atlantic Environmental Zone of Influence



EEZ boundary

Saxavord Spaceport

Environmental Zone Of Influence

ERM

World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Reference: Esri, TomTom, Garmin, FAO, NOAA, USGS
World Ocean Reference: Esri UK, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

0 250 500 km

Scale 1:10,000,000 @ A3

ORBEX aurora

Orbex
Assessment of Environmental Effects

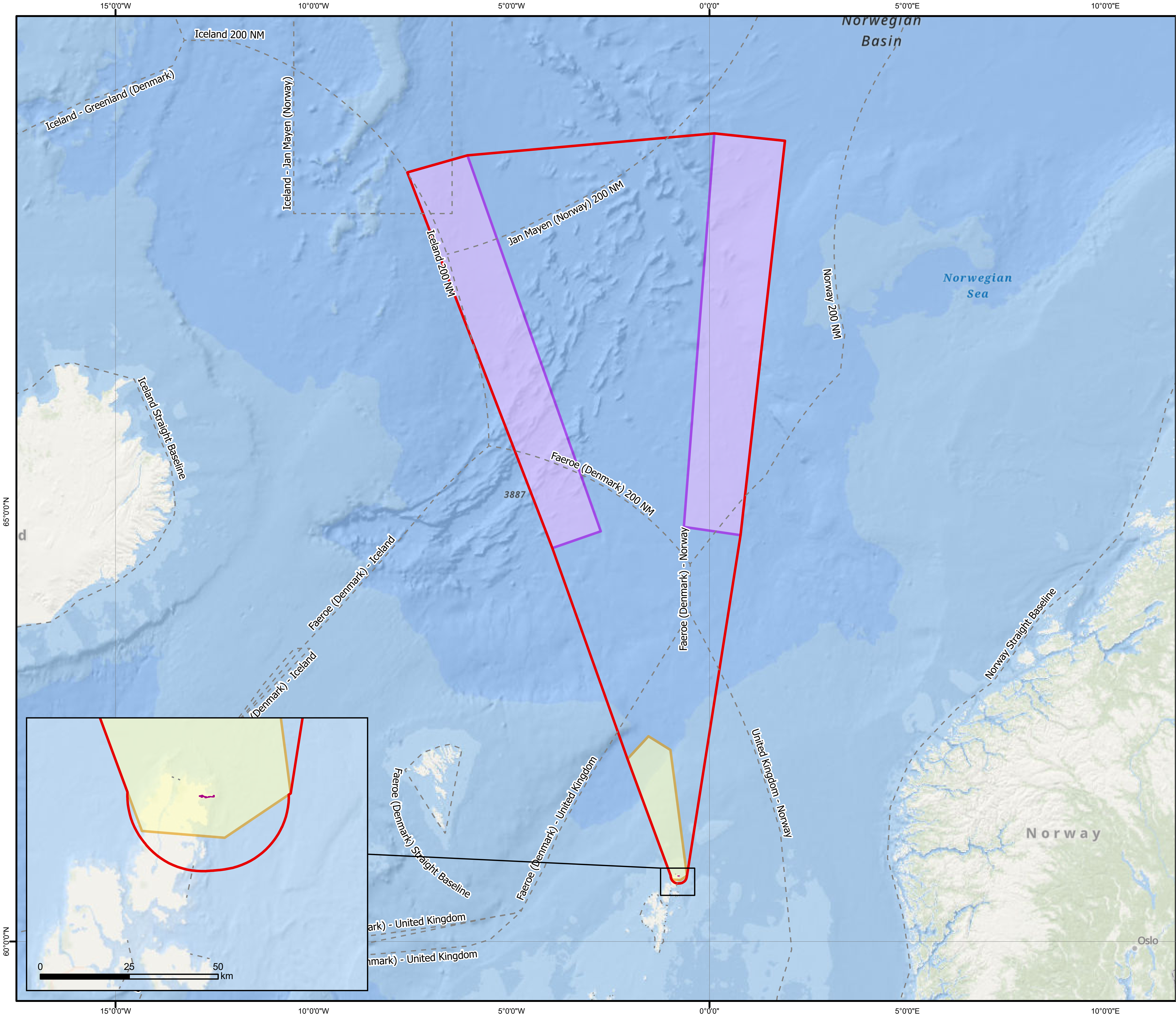
Drawing 10.1

North Atlantic Environmental Zone of Influence

Date: 2/21/2025	Drawn by: MW	Checked by: LD	Version: Draft/V1

Project Number: 765856

Chapter 10 Drawing 10.2 North Atlantic EZI Drop Zones



EEZ boundaries

Environmental Zone Of Influence

Orbital Impact Zone

Suborbital Launch Impact Zone

Saxavord Spaceport

ERM

World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Reference: Esri, TomTom, Garmin, FAO, NOAA, USGS
World Ocean Reference: Esri UK, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

N

0 250 500 km

Scale 1:10,000,000 @ A3

ORBEX aurora

Orbex
Assessment of Environmental Effects

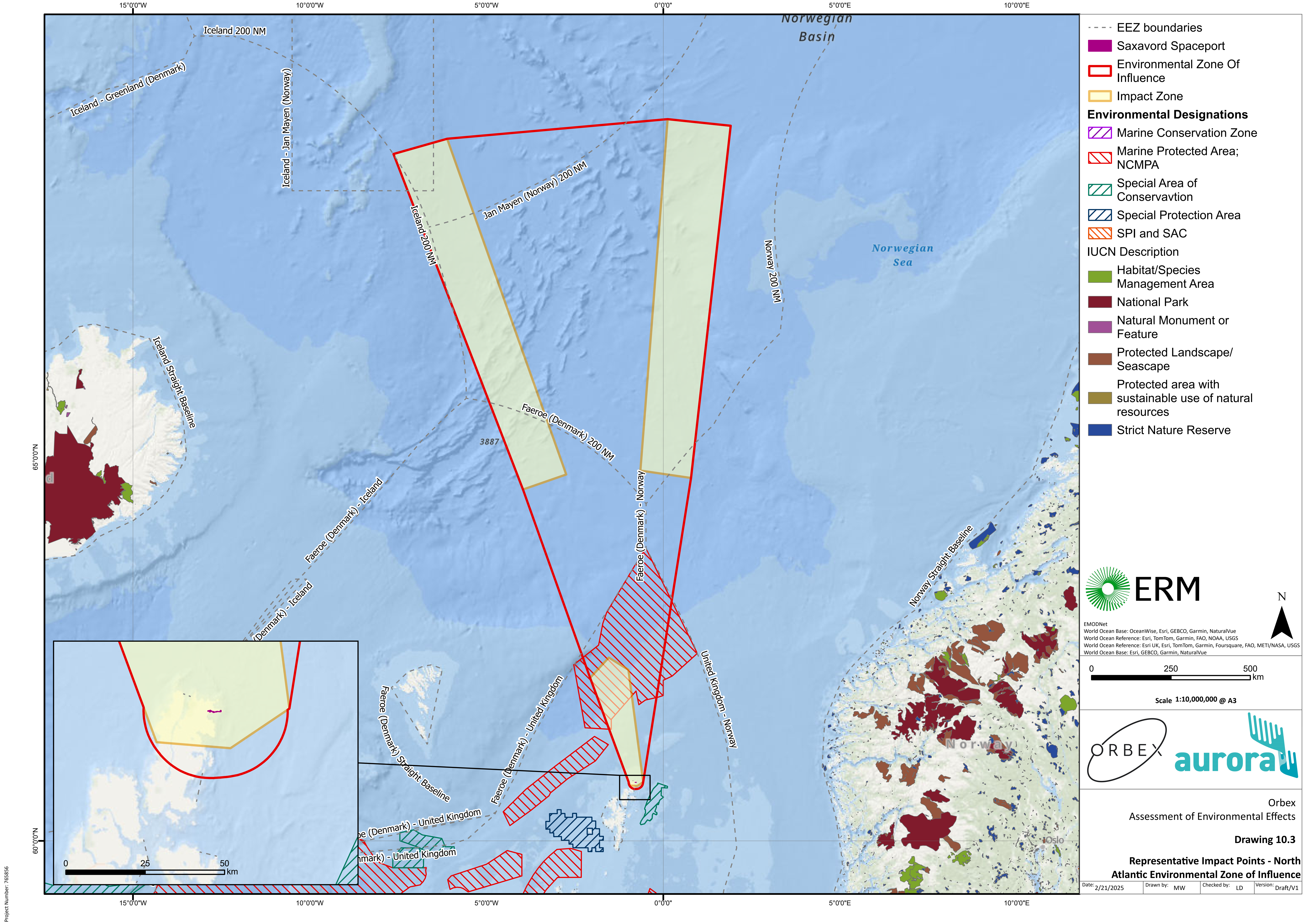
Drawing 10.2

Representative Impact Points - Northern Atlantic Environmental Zone of Influence

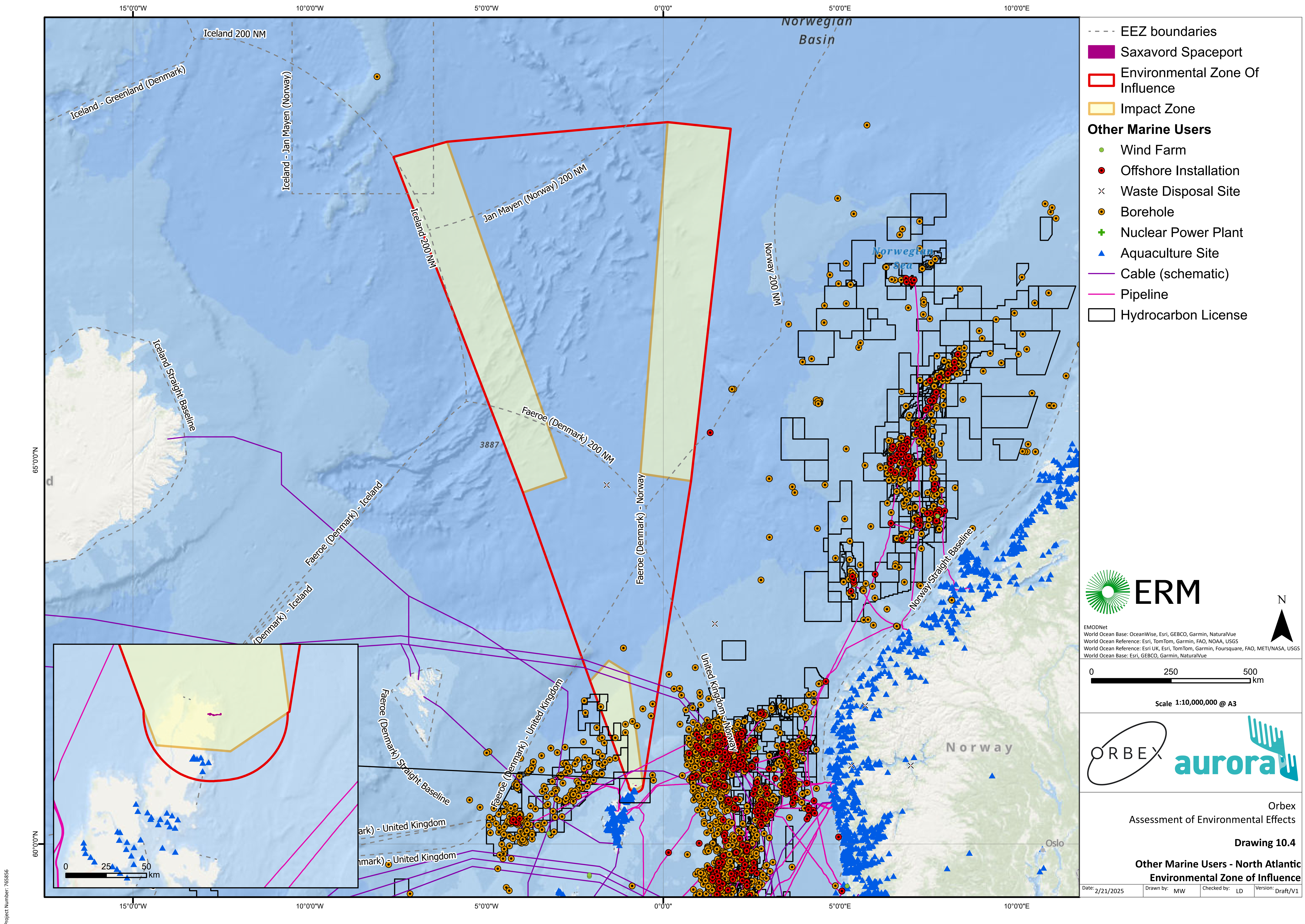
Date: 2/21/2025	Drawn by: MW	Checked by: LD	Version: Draft/V1

Project Number: 765856

Chapter 10 Drawing 10.3 Marine Protected Areas

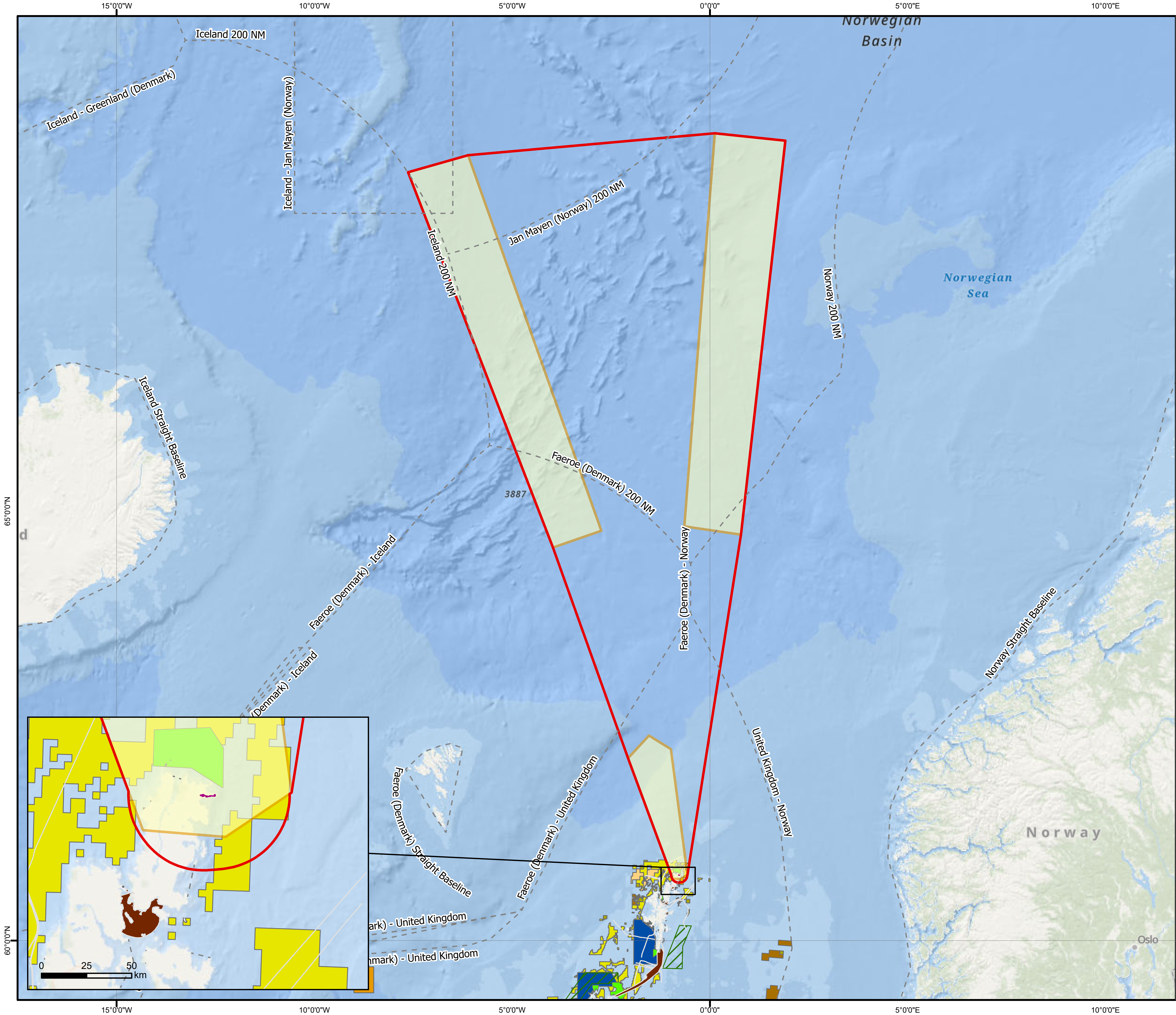

15°0'0"W
10°0'0"W
5°0'0"W
0°0'0"
5°0'0"E
10°0'0"E
65°0'0"N
60°0'0"N
Norwegian Basin
Norwegian Sea
Iceland 200 NM
Iceland - Greenland (Denmark)
Iceland - Jan Mayen (Norway)
Jan Mayen (Norway) 200 NM
Iceland 200 NM
Norway 200 NM
Iceland Straight Baseline
Faeroe (Denmark) 200 NM
3887
Faeroe (Denmark) - Iceland
Faeroe (Denmark) - Iceland
Faeroe (Denmark) - Norway
United Kingdom - Norway
Norway Straight Baseline
Faeroe (Denmark) Straight Baseline
Faeroe (Denmark) - United Kingdom
Faeroe (Denmark) - United Kingdom
Faeroe (Denmark) - United Kingdom
Norway
Oslo
0
25
50
km
EEZ boundaries
Saxavord Spaceport
Environmental Zone Of Influence
Impact Zone
Environmental Designations
Marine Conservation Zone
Marine Protected Area; NCMPA
Special Area of Conservavtion
Special Protection Area
SPI and SAC
IUCN Description
Habitat/Species Management Area
National Park
Natural Monument or Feature
Protected Landscape/ Seascape
Protected area with sustainable use of natural resources
Strict Nature Reserve
ERM
N
EMODNet
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Reference: Esri, TomTom, Garmin, FAO, NOAA, USGS
World Ocean Reference: Esri UK, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue
0
250
500
km
Scale 1:10,000,000 @ A3
ORBEX
aurora
Orbex
Assessment of Environmental Effects
Drawing 10.3
Representative Impact Points - North Atlantic Environmental Zone of Influence
Date: 2/21/2025
Drawn by: MW
Checked by: LD
Version: Draft/V1
Project Number: 765856

Chapter 10 Drawing 10.4 Other Marine Users



15°0'0"W
10°0'0"W
5°0'0"W
0°0'0"
5°0'0"E
10°0'0"E
65°0'0"N
60°0'0"N
Norwegian Basin
Norwegian Sea
Iceland 200 NM
Iceland - Greenland (Denmark)
Iceland - Jan Mayen (Norway)
Jan Mayen (Norway) 200 NM
Iceland 200 NM
Norway 200 NM
Iceland Straight Baseline
Faeroe (Denmark) 200 NM
3887
Faeroe (Denmark) - Iceland
Faeroe (Denmark) - Norway
United Kingdom - Norway
Norway Straight Baseline
Faeroe (Denmark) - United Kingdom
Faeroe (Denmark) Straight Baseline
Norway
Oslo
0
25
50
km
EEZ boundaries
Saxavord Spaceport
Environmental Zone Of Influence
Impact Zone
Other Marine Users
Wind Farm
Offshore Installation
Waste Disposal Site
Borehole
Nuclear Power Plant
Aquaculture Site
Cable (schematic)
Pipeline
Hydrocarbon License
N
EMODNet
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Reference: Esri, TomTom, Garmin, FAO, NOAA, USGS
World Ocean Reference: Esri UK, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue
0
250
500
km
Scale 1:10,000,000 @ A3
Orbex
Assessment of Environmental Effects
Drawing 10.4
Other Marine Users - North Atlantic Environmental Zone of Influence
Date: 2/21/2025
Drawn by: MW
Checked by: LD
Version: Draft/V1
Project Number: 765856

Chapter 10 Drawing 10.5 Current and Potential Use of Marine Environment



- EEZ boundaries
- Saxavord Spaceport
- Environmental Zone Of Influence
- Impact Zone

Current and Potential Use

- Energy Infrastructure Agreements
- Tidal Draft Plan Option
- Offshore Wind Energy Draft Plan Option
- Wave Draft Plan Option

Disposal Site Status

- Open
- Closed
- Disused

Sand And Gravel Resources

- Construction Aggregate - Course
- Construction Aggregate - Fine (Course Sand)
- Construction Aggregate - Fine (Fine Sand)
- Fill Aggregate

ERM

EMODNet
World Ocean Base: OceanWise, Esri, GEBCO, Garmin, NaturalVue
World Ocean Reference: Esri, TomTom, Garmin, FAO, NOAA, USGS
World Ocean Reference: Esri UK, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS
World Ocean Base: Esri, GEBCO, Garmin, NaturalVue

N

0 250 500 km

Scale 1:10,000,000 @ A3

ORBEX aurora

Orbex
Assessment of Environmental Effects

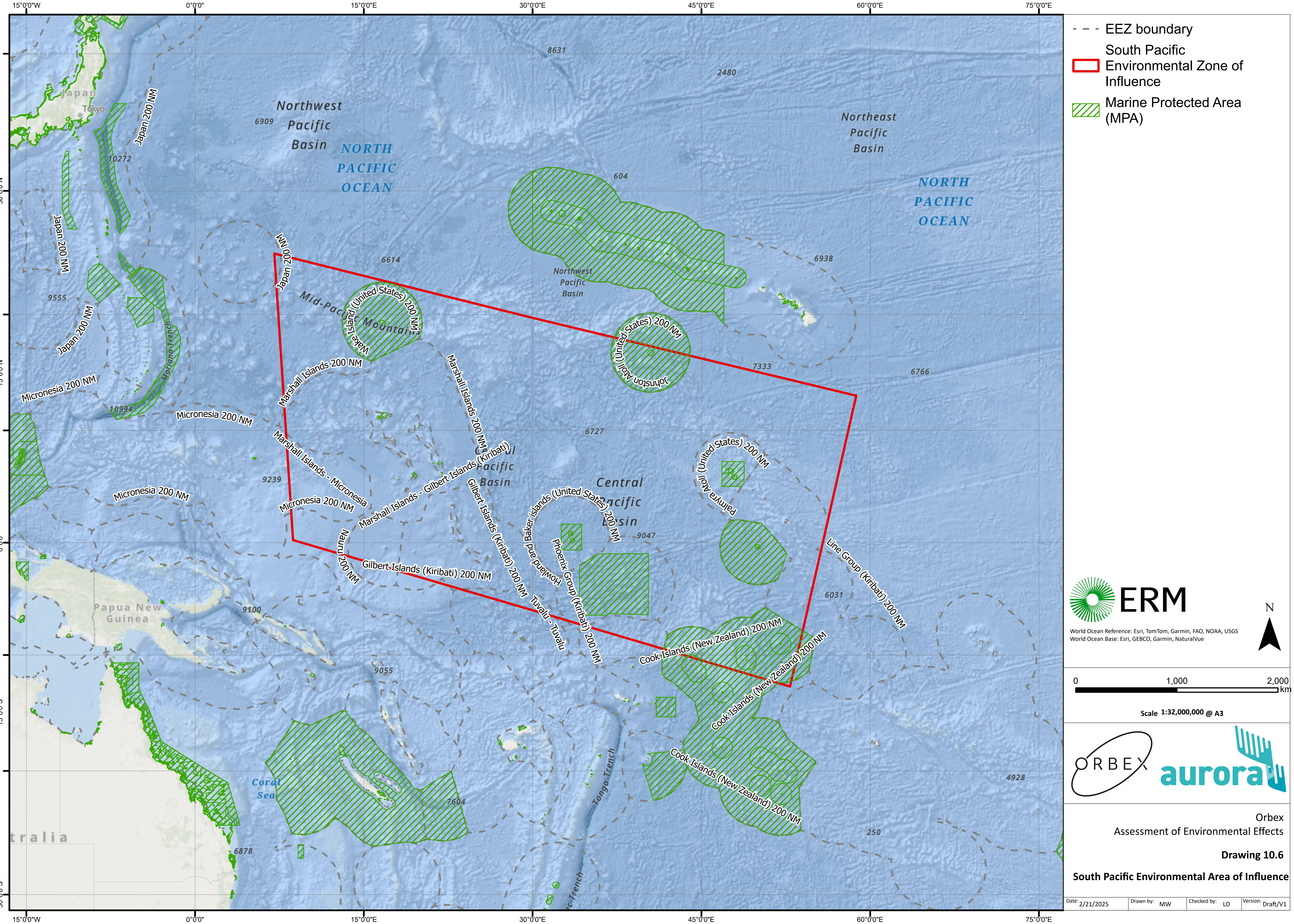
Drawing 10.5

Current and Future Use - North Atlantic Environmental Zone of Influence

Date: 2/21/2025	Drawn by: MW	Checked by: LD	Version: Draft/V1

Project Number: 765856

Chapter 10 Drawing 10.6 South Pacific EZI - Stage 2 Return



Orbex
Assessment of Environmental Effects

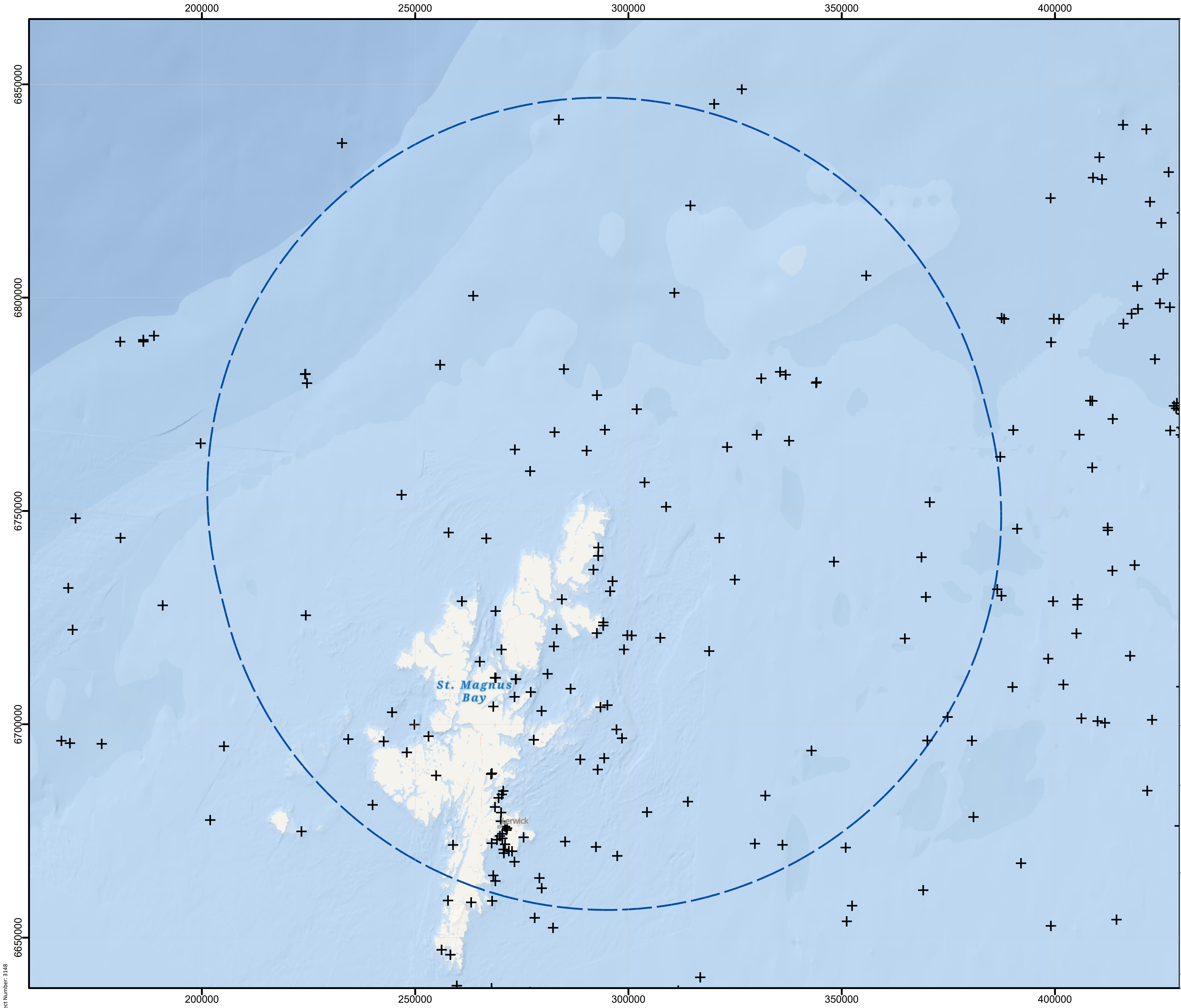
Drawing 10.6

South Pacific Environmental Area of Influence

Date: 2/21/2025 | Drawn by: MW | Checked by: LD | Version: Draft/V1

Project Number: 765856

Chapter 10 Drawing 10.7 North Atlantic EZI - Wrecks



Wrecks
90km Archaelogical Buffer

ERM

World Ocean Base: OceanWise, Esri, Garmin, NaturalVue
World Ocean Reference: Esri UK, Esri, TomTom, Garmin, Foursquare, FAO, METI/NASA, USGS

N

0 20 40 km

Scale 1:820,000 @ A3

ORBEX

aurora

Orbex
Assessment of Environmental Effects

Figure A10.7

North Atlantic Wrecks

Date: 2/21/2025	Drawn by: MW	Checked by: LD	Version: Draft/V1

Project Number: 765856
Project Number: 3148

Chapter 11 -

Volume IV AEE Technical Appendices

Appendix 1.1 CVs

Ruth Fain, MGeol (Hons.) CSci MIEnvSc MIAQM

Ruth is a Chartered Scientist and Member of the Institute of Environmental Sciences with over 20 years' experience. Ruth specialises in the assessment of environmental effects (AEE) of UK Spaceflight activities, Environmental Impact Assessment (EIA) for large industrial and infrastructure projects and general environmental regulatory compliance for a wide range of industrial, manufacturing and renewable energy clients.

With a focus on planning and permitting regimes for both the space Industry and terrestrial development, Ruth is experienced in all aspects of environmental regulation and management. She uses this operational knowledge in her development project management, bringing a whole project approach to the planning and design stages. Ruth is Director of Aurora Environmental Consulting Limited.

Education

- MGeol (Hons) Environmental Geology

Selected Project Experience

Space

Planning Application, United Kingdom, SaxaVord Spaceport 2020-2022

Project management and delivery of EIA as part of major planning application for the UK's first vertical launch space port and associated infrastructure at Lamba Ness. Assessment over three years with particular focus on marine and transboundary effects, minimisation of impact on scheduled monuments and assessment and mitigation of effects on a diverse bird and animal population. Support to the public consultation process and ad hoc technical advice.

AEE in support of Spaceport Operator Licence, United Kingdom, SaxaVord Spaceport 2021-2023

Project management and delivery of Assessment of Environmental Effects (AEE) to the Civil Aviation Authority in support of Spaceport Operator License Application under the Space Act 2018. Management and reporting of AEE focusing on operation effects of launching small satellites from the three vertical launchpads on Unst. Similar scopes undertaken for the following Launch Vehicle Operator clients.

AEE in support of Launch Operator Licence (Suborbital), Poland, Lukasiewicz Research Network – Institute of Aviation 2023

AEE in support of Launch Operator Licence (Orbital), USA, ABL Space Systems 2022-2024

AEE in support of Launch Operator Licence (Orbital and suborbital), Germany, Rocket Factory Augsberg 2022-2024

AEE in support of Launch Operator Licence (Orbital and suborbital), United Kingdom, Skyrora 2022-2024

AEE in support of Launch Operator Licence (Orbital and suborbital), United Kingdom, Orbex Express Launch 2025

Environmental Impact Assessment

Electric Arc Furnace, British Steel Teesside, 2023

Project management and delivery of EIA as part of successful planning application for an electric arc furnace conversion project at British Steel.

Billet and Casting Facility, Alvance British Aluminium, 2022

Project management and delivery of EIA for development of a 12,254 m2 billet and casting facility in Fort Willaim. Works included multi-discipline EIA, flood risk management, drainage strategy design and peat management planning billet and peat management planning.

Combined Cycle Power Plant, Sembcorp, 2022

Project management and delivery of EIA Air Quality, Noise and Greenhouse gas assessment works to support DCO variation required by design change to alternative technology.

Impact assessment in support of planning application, Conrad Energy, 2022-2024

Project management and delivery of Environmental Information Reports covering noise, landscape and traffic effects of synchronous condenser developments in Teesside and Suffolk.

Hilthorn Business Park - Sunderland, Legal and General, 2021

Management and delivery of EIA technical input for a large industrial business park.

Distilleries (Scotland), Various, 2019-2024

Project management and delivery of development EIA for proposed distilleries including Glenmorangie, Glenrothes and a new distillery in Jedburgh. Multi-disciplinary assessment of construction and operational effects in accordance with appropriate standards.

Mining Development, Confidential Client, Gabon, 2017-2019

EIA assessment including air quality monitoring (in-field) to support a World Bank standard environmental and social impact assessment for the construction and operational phase of a mine in Gabon, Africa.

Motorway, Kosovo Ministry of Transport, Kosovo, 2014-2017

World Bank standard environmental and social impact assessment for the construction and operational phase of the Kosovo Motorway Project. Assessment of impacts on air quality of a 102 km dual carriageway road scheme.

Consenting – Industrial

PPC / EP permit applications, variations and surrenders

Project management and delivery of PPC/ EP permit applications, variations and surrenders for clients in the Manufacturing, Power, Oil and Gas and Waste sectors including Nestlé, Refresco, British Nuclear Group, Egdon Resources, National Oilwell Varco, AES Kilroot, Biffa, Shanks Waste Solutions, Princes, Thomas Hardy Group, Gilbertson and Page, and Premier Foods. Support during negotiations with regulatory authorities, coordination of specialist studies and ongoing compliance and stakeholder engagement work.

Long term regulatory compliance support / Environmental Advisor

Provision of long term environmental compliance advice and support to various UK manufacturers including Nestlé UK, Refresco Beverages, Gilbertson and Page. Works including emissions dispersion modelling, odour impact assessment, Best Available Technique (BAT) assessment, cost benefit analysis and general EP compliance support during planning, permitting and divestiture stages of operation. Various sites across the UK. Regularly liaising between site contacts, regulators, client and external legal advisors and client commercial/PR teams regarding issues of nuisance, civil claims, EP permit breaches and transactional risk management.

Technial Guidance

Best Practice Guidance on Assessment of Environmental Effects for the Space Industry, CAA / Industry 2024-ongoing

Working group chair and co-author of forthcoming best practice guidance on methodologies for assessment of environmental effects in the space industry.

Guidance on the Assessment of Odour for Planning, Institute of Air Quality Management, 2014 (updated 2018)

Co-author of IAQM document prepared to assist practitioners involved in odour assessment for planning.

Memberships and Associations

- Chartered Scientist (CSci)
- Member of the Institute of Environmental Sciences (MIEnvSc)
- Member of the Institute for Air Quality Management (MIAQM)
- NEBOSH General Certificate in Occupational Health and Safety (Distinction)

Gavin Bollan, BSc (Hons.) CEnv CSci FIAQM MIEnvSc

Technical Director | Energy Advisory | London

Gavin has over 30 years of experience in the environment industry, more than 25 years of which has been in consulting. He has been active in EIA, air quality and climate change assessment during this time and has been closely involved in environmental permitting since the 1990s. Gavin is an analytical chemist by training, and his consulting career has focussed on pollution management and control for emissions to air (including greenhouse gases) and water.

Sectors in which he has particular experience include the space industry, green hydrogen and chemical derivatives, metals, pharmaceuticals, energy recovery, thermal power, food and beverage and chemicals.

He has also worked on some of the UK's largest infrastructure projects including major highway upgrades, high speed rail and the development of the Olympic Park. He has been called as Expert Witness on air quality matters on several occasions in the UK (England, Scotland and Northern Ireland) the Republic of Ireland and eastern Europe.

Education

- BSc (Hons.) Environmental Science

Project Experience

Space sector

Planning Application, United Kingdom, SaxaVord Spaceport 2020-2022**

Development of novel assessment methodologies for climate change impacts and resilience, and the effects of major accidents and disasters from the UK's first vertical-launch spaceport to support a successful planning application to Shetland Islands Council. Support to the public consultation process and ad hoc technical advice.

AEE / License Application, United Kingdom, SaxaVord Spaceport 2021-2023**

Climate change and Major Accidents and Disasters chapters for the Assessment of Environmental Effects. Multiple rounds of engagement with the CAA. Project Director. Similar scopes were undertaken for the following Launch Vehicle Operator clients.

AEE / License Application, USA, ABL Space Systems 2022-2024**

AEE / License Application, Poland, Lukasiewicz Research Network – Institute of Aviation 2023**

AEE / License Application, Germany, Rocket Factory Augsberg 2022-2024**

AEE / License Application, United Kingdom, Skyrora 2022**

AEE / License Application, United Kingdom, Orbex Express Launch 2025

Modern Molecules

Multiple projects, Protium Green Solutions, 2021-2024**
Project Director of multidisciplinary team providing site selection, energy yield analysis, environmental surveys, consent applications and design for solar and battery storage subsystems. Five projects in England, Scotland and Wales.

Consenting Strategy Development, H2Green, 2022-2023**
Scoping and management of constraints mapping and consenting strategy for a major brownfield hydrogen production facility. Early engagement with local planning authority.

**Denotes experience completed at another firm

Consent applications, RES / Octopus, 2023 – date**
Preparation of multiple consent applications supported by environmental risk assessments and analysis of Best Available Techniques (BAT) for pollution control

Site selection, stakeholder engagement and consenting strategy, Confidential Client, 2023 – date**
Early stage constraints and opportunity mapping for two national-scale green ammonia plant.

Renewables

Portfolio Carbon Footprinting for mandatory GHG reporting, Schroders Greencoat, 2022-date**
Project Director and Quality Assurance for GHG reporting on five major renewables asset funds, including solar and onshore wind.

GHG screening tool for EU Taxonomy, Denham Capital, 2023**
Project manager for tool development to assess compliance with EU Taxonomy for a client with a mixed portfolio of renewable and thermal assets.

Circular economy briefing, Inchcape Wind, 2022**
Development of in-house guidance for offshore wind developer on supply chain sustainability

Delivery of HydroGlen, James Hutton Institute, 2021–2024**
Project director for full project and consent management, including contractor selection, for a microgrid wind / solar / battery / electrolyser / fuel cell system funded by the Scottish government on a remote farm in northeast Scotland.

Impact assessment in support of planning application, Conrad Energy, 2022-2024**
Co-ordinator of Environmental Information Reports covering noise, landscape and traffic effects of synchronous condenser developments in Teesside and Suffolk.

Technical Due Diligence, Stream Bioenergy, 2023-2024**
Half of two person TDD team advising on the acquisition of a major biogas production facility in Scotland.

Expert witness

Swedish Chamber of Commerce (SCC) Arbitration: IVICOM vs Albania, HKA on behalf of Clifford Chance acting for the Republic of Albania, 2022-2024**
Respondent's principal expert on environmental issues in a dispute over the award of an environmental consent to a 500MWe thermal power station in Albania. Preparation of expert reports and presentations / cross examination before the tribunal.

Expert Witness on air quality, Highways Agency / local authorities in Republic of Ireland, Northern Ireland and Scotland, 2005-2010**
Development and presentation of proofs of evidence on various transport scheme air emissions.

Consenting - Industrial

Client's agent for planning and permitting processes, Simec Uskmouth Energy, 2018-2021**
Management of major process variation EIA and permitting process for the conversion of a thermal power station to sustainable fuel

Environmental Permit application, Johnson Matthey, 2018**
Development of complete bespoke permit application pack and post-submission support for a new manufacturing process for fuel cell components

Environmental Permit applications, Equinix, 2017-2018**
Turnkey management of several permit applications for major data centres with on-site thermal power backup systems, among the first in the UK to follow the Draft Data Centre Permitting Guidance

Cost-benefit analysis, Cristal, 2018**
Calculation of air quality impacts using conventional atmospheric dispersion modelling to examine several abatement options and undertook cost-benefit analysis based on environmental damage costs, carbon prices and investment costs.

BAT assessment, Fluor (Guinea), 2017**
Assessment of BAT to EU, US, Chinese, Brazilian and IFC standards and abatement plant cost-benefit analysis for a mineral calcining plant.

Emissions Inventory, Permit Support, Process Safety Investigations, Aesica Pharmaceuticals, 2016-2018**
Project manager for multiple event modelling exercises and a site-wide process safety and human factors review.

BAT assessment and Permit Variation, PQ Silicates, 2016-2018**
Established BAT requirements for new thermal and inorganic chemical plants as part of Permit Variation process. Large Combustion Plant BAT compliance.

Permit Support, Onshore Gas Processing, eni, 2013-2017**
Project Manager for support around process characterisation, modelling and Variation administration.

BAT assessment, ITW, France, 2014**
Support to client in the specification and procurement of VOC abatement systems

Environmental Permitting System Development Royal Commission for Jubail and Yanbu (Saudi Arabia), 2013 – 2018**
Adviser on improvements to environmental regulation and international best practice in regulation and industrial permitting. Development of country-specific BAT guidance for power stations, primary aluminum, steel, copper and zinc facilities and fertiliser plant.

Permit Support, Beverages, UCP, 2014-2015**
Project Manager for services including process characterisation, modelling, improvement conditions, odour perception and Variation administration.

Permitting and BAT Technical Review, 2013-2018**
Technical review of Permit support documents for EP Applications from Total, SASOIL, Baker Hughes.

Odour Management Plans, BAT Technical Review, Permit Variation Support, Archer Daniels Midland Company, 2015-2018**
Modelling and monitoring plans for a large edible oil refinery. BAT assessment for a portfolio of abatement plant including scrubbers, biotreatment and thermal oxidation.

Environmental Permitting Management, Baird & Co. Ltd, 2002-2017**
Long-term environmental and health & safety compliance management for a Part A precious metals process including Permit Application, Surrender, Re-Application and Variation. Support for specification of gaseous and particulate abatement systems.

Impact Assessment

Environmental Impact Assessment, British Steel, 2023**
Oversight of climate change and waste chapters and preparation of major accidents and disasters chapter for electric arc furnace conversion project.

**Denotes experience completed at another firm

Impact Assessment for Industrial City, Saudi Arabia, Royal Commission, 2013-2018**
Full environmental and social assessment and regulatory review for Ras al Khair industrial city project in Eastern Province. Responsible for client liaison and technical governance for ERM's largest project in the Middle East your job experience with names of clients, date and our role.

Aluminum Refinery and Smelter, Hydro/Qatalum (Qatar), 2008-2009**
Project Manager for the Air Quality chapter in an Environmental Impact Assessment for the first primary aluminum production facility in Qatar. Air quality effects were modelled using the USEPA AERMOD model and compared with national and international air quality criteria. Duties included visits to Qatar to work with local contractors in establishing a temporary air quality monitoring station on the future site of the development to characterise baseline conditions.

Emissions Trading

Pre-verification support, New Entrant Reserve application management and METS submissions, Confidential Client, 2024**

Pre-verification support and audit, Options analysis for ETS participation and withdrawal, Refresco, 2021-2023**

New Entrant Reserve Application Management and Preparation of all NIMS forms for Verification, eni, 2019-2020**

ETSWAP Reporting, Talisman, 2012**

EU ETS Capacity Building, Scotland, SEPA, 2003 -2007**
Project Manager. Development of monitoring and reporting strategy and templates with the Scottish Environmental Protection Agency (SEPA). Technical assessment of Scottish Monitoring and Reporting Plans. Design and implementation of procedural and technical assessment systems for the suitability of greenhouse gas Monitoring and Reporting plans for over 120 permit holders in Scotland. Personally inspected over 10 sites to assess the quality of submissions.

Technical Guidance

Renewables UK Working Group member for "Planning for Onshore Green Hydrogen" guidance, 2023**
(www.renewableuk.com/resource/resmgr/renewableuk_gh_report_web__3.pdf)

Development of permitting regime, Saudi Arabian Royal Commission, 2013-2018**
Project Manager. Extensive recommendations for overhauling permitting policy and procedures with regard to (amongst others) BAT, air quality monitoring, marine and groundwater monitoring, energy management, operator competencies etc. Regulatory Impact Assessment using Monte Carlo analysis of costed options, Cost-Benefit Analysis examining capital and operational cost model and human health impact assessment.

Air Quality Risk Management Guidance, Thames Water, 2012**
Production of comprehensive corporate air quality management guidance for staff training and management system purposes.

Carbon technical guidance, Atkins, 2008-2010**
Principal Author of Atkins' internal guidance series on carbon measurement and management. The Carbon Manuals were intended for staff and clients to raise awareness of how our activities contribute to climate change, how the international community is legislating for it and what practical steps towards mitigation exist.

Air Quality Technical Guidance, Environment Agency, 1998-2003**
Several technical guidance manuals, many still currently available freely by searching by reference number (e.g. "M17" at www.environment-agency.gov.uk) as part of a two-person research team.

Development of permitting regime, Saudi Arabian Royal Commission, 2013-2018**
Project Manager. Extensive recommendations for overhauling permitting policy and procedures with regard to (amongst others) BAT, air quality monitoring, marine and groundwater monitoring, energy management, operator competencies etc. Regulatory Impact Assessment using Monte Carlo analysis of costed options, Cost-Benefit Analysis examining capital and operational cost model and human health impact assessment.

EU ETS Capacity Building, Scotland, SEPA, 2003 -2007**
Project Manager. Development of monitoring and reporting strategy and templates with the Scottish Environmental Protection Agency (SEPA). Technical assessment of Scottish Monitoring and Reporting Plans. Design and implementation of procedural and technical assessment systems for the suitability of greenhouse gas Monitoring and Reporting plans for over 120 permit holders in Scotland. Personally inspected over 10 sites to assess the quality of submissions.

Air Quality Risk Management Guidance, Thames Water, 2012**
Production of comprehensive corporate air quality management guidance for staff training and management system purposes.

Carbon technical guidance, Atkins, 2008-2010**
Principal Author of Atkins' internal guidance series on carbon measurement and management. The Carbon Manuals were intended for staff and clients to raise awareness of how our activities contribute to climate change, how the international community is legislating for it and what practical steps towards mitigation exist.

Air Quality Technical Guidance, Environment Agency, 1998-2003**
Several technical guidance manuals, many still currently available freely by searching by reference number (e.g. "M17" at www.environment-agency.gov.uk) as part of a two-person research team.

Memberships and Associations

- Chartered Environmentalist (CEnv)
- Chartered Scientist (CSci)
- Member of the Institution of Environmental Sciences (MIEnvSc)
- Fellow of the Institute of Air Quality Management (FIAQM)

**Denotes experience completed at another firm

CURRICULUM VITAE

Dr Peter J Cosgrove

Name:	Dr Peter J Cosgrove, FCIEEM
Date of Birth:	19 June 1969
Based:	Grantown on Spey, Highland
Profession:	Environmental Scientist
Specialisation:	Ecologist
Email contact:	petercosgrove@albaecology.co.uk

Fellow of the Chartered Institute of Ecology and Environmental Management (FCIEEM)

Recent Career Summary:

2018-on-going	Managing Director of Alba Ecology.
2023-on-going	Board member, Cairngorms National Park Authority.
2011–2018	Director of Ecology with Alba Ecology.
2009-2011	Principal Ecologist with Alba Ecology.
2005–2009	Principal Ecologist with EnviroCentre.
1998-2009	Freshwater Ecologist, Independent Ecological Consultant.
2004-2005	Ecology and Landscape Advisor, Cairngorms National Park Authority.
1998-2003	Cairngorms Biodiversity Officer, Cairngorms Partnership/National Park Authority.
1998	Wildlife Crime Investigations Officer, RSPB.
1995-1998	Ecological Research Fellow, Aberdeen University.

Education:

1991-1995	PhD. Zoology, University of Aberdeen.
1987-1991	BSc. (Hons) 2[1] Environmental Studies, University of Hertfordshire.

Profile:

Peter is a highly skilled ecologist with thirty years' experience in wildlife and habitat research, land-use management, conservation planning and policy development and environmental assessments. He has managed many large projects and budgets from conception through to completion and has a strong proven track record of delivery in both the public and private sector, producing over 150 peer-reviewed scientific papers, commissioned reports and books. In particular, Peter specialises in bringing consensus to difficult conservation issues through innovative approaches to partnership working, publishing applied research, negotiation and conflict resolution. In the last decade Peter has focussed his efforts on freshwater pearl mussels, invasive species, species reintroduction, environmental impact assessment, ecological clerks of work, forestry management and renewable energy developments.

Peter's work has concentrated primarily in six areas: (1) Co-ordinated the development and implementation of over 100 action plans with partners, for a quarter of the UK's most threatened habitats and species; (2) Provided advice and guidance on conservation, planning and development control issues in designated and non-designated areas and has a thorough working knowledge of national and international designation issues, especially Natura 2000 sites and carrying out Appropriate Assessments; (3) Delivery of ecological elements of EIAR, Ecological Clerks of Work, expert witness testimony at Public Local Inquiry and negotiation with statutory authorities and private sector; (4) Specialised in invasive species issues in Ireland, the UK and internationally; (5) Communication of often complex biodiversity/conservation information and messages effectively to different audiences; and (6) Recognised as an international authority on the survey and conservation of the endangered freshwater pearl mussel and its aquatic habitat.

In 2023, the Scottish Government appointed Peter to be a Member of the Board of Cairngorms National Park Authority (CNPA).

Relevant Experience:

- *Freshwater pearl mussel advisor*

Over 200 commissioned pieces of work for the public and private sector on aquatic casework issues for development control, surveying and conservation management of this endangered species. During the last decade this has included Site Condition Monitoring for all of Scotland's SACs and SSSIs where *M. margaritifera* is a feature. Advisory work has included developing, testing and publishing standard deepwater survey methods for the species, advising on the removal of a fish counter on an SAC and a feasibility study for improving fish passage on another two pearl mussel SAC rivers and producing leaflet and on-line guidance on freshwater pearl mussels for developers operating in rivers in Scotland. Since 2000, Peter has been on special 'call-off' contract for the provision of expert advice on freshwater pearl mussels to the Scottish Natural Heritage (now NatureScot) and Forestry and Land Scotland and has recently concentrated on developing and implementing a project entitled the '*Restoration of freshwater pearl mussels in selected Scottish rivers*'. During 2013-2015 Peter completed SNH's 2nd national freshwater pearl mussel survey across Scotland and has published the findings. In 2020, Peter wrote CIEEM's COVID-19 freshwater pearl mussel survey guidance. Since 1996 Peter has surveyed over 1,300 Scottish watercourses for freshwater pearl mussels.

- *Invasive species*

Provision of expert advice leading to the development and implementation of this best-practice cross-border invasive species programme in Northern Ireland and the Republic of Ireland.

- *Ecological project co-ordination*

Project co-ordination and logistical management of large-scale development projects, including the management of Ecological Clerks of Work teams across Scotland. For example, completed the delivery of biodiversity/habitat management plans for two large developments near Glasgow. The first for a 900 housing unit application and the second for a new road. The work involved updating old ES's and negotiating detailed and costed timetabled action plans for delivery of the mitigation measures outlined in the ES and also the concerns raised by the regulators (primarily local authorities and the statutory nature conservation agency). In 2012, Peter successfully completed delivery of ECoW support for the Trump Golf Development on Menie Estate, Aberdeenshire. Peter is currently providing ECoW support on several large-scale projects in northern Scotland, ranging from wind farms, housing developments, a whisky distillery and bridge repair works.

- *Biodiversity Action Plan work, habitats and species*

A thorough working knowledge of most of Scotland's terrestrial and aquatic protected species and habitats, the experts who work on them and the UK BAP process. Development of standardised ecological survey methodologies and conflict resolution strategies for 'problematical' high-profile species. Development of project briefs, securing funding, management and implementation of many practical biodiversity projects in the north of Scotland. In 2020 Peter co-authored, with Alba Ecology a feasibility study for reintroducing cranes into the Cairngorms National Park.

- *Provision of expert advice on national and European conservation designations*

Provision of expert advice to competent authorities (e.g. Cairngorms National Park Authority, The Crown Estate, Irish Sea Fisheries Board and SNH) on conservation designation issues in relation development control. Peter has completed ca. 50 Appropriate Assessments for competent authorities. Peter has also provided expert witness testimony at Public Local Inquiries in Scotland (e.g. Achany Wind Farm, Caplich Wind Farm, Coul Links Golf Course).

- *Delivery of ecological elements of renewable energy EIA and ES*

In the last decade Peter has successfully contributed to the delivery of over 50 onshore wind farm ES's/EIAR chapters (ranging in size from 7-103 turbines) and many small-medium sized wind farms (list available upon request) and other high-profile projects such as the Shetland (SaxaVord) Space Centre.

Examples of recent delivery of commissioned work:

- Principal ecological/ornithological advisor on the proposed Shetland Space Centre.
- Cairngorms Crane Project: Feasibility Study for Crane Reintroduction, Scotland: The Big Picture and the Cairngorms National Park Authority.
- Development and publication of best practice guidance for forestry and peatland management and freshwater pearl mussels, Forestry and Land Scotland.
- Principal ecological/ornithological advisor on 2 on-shore wind farm, Peel Energy.
- Principal ecological/ornithological advisor on 3 on-shore wind farm, ABO Wind.
- Principal ecological advisor on-shore wind farm, WKN AG.
- Principal ecological advisor on 5 on-shore wind farms, SSE Renewables.
- Freshwater pearl mussel guidance for numerous clients operating in and around rivers.
- Site Condition Monitoring for all Scottish freshwater pearl mussel SACs, SNH/NatureScot and led surveys of all of Scotland's known pearl mussel rivers as part of the 2nd national survey for the species.
- Developed, co-ordinated and implemented the first successful Scottish reintroduction for the globally threatened freshwater pearl mussel, SNH.
- Co-ordination and production of 44 Appropriate Assessments for aquaculture operations in Scottish Natura 2000 sites, Crown Estate.
- Development of Irish Screening Protocol for Aquaculture operations in Natura 2000 sites, Irish Sea Fisheries Board.
- Ecological Clerk of Works co-ordinator for Menie Estate, Trump International Golf Links Scotland.
- Expert ornithological witness, on-shore windfarm, N Scotland, Scottish and Southern Energy.
- Expert ornithological/ecological witness, proposed Coul Links Golf Course.
- Ecological advisor and ECoW co-ordinator for new road, Kirkintilloch Initiative.
- Project manager writing and reviewing the Highland Biodiversity Action Plan, Highland Council.
- As Biodiversity Officer and Ecology and Landscape Advisor in the Cairngorms National Park, provided advice and guidance on conservation and casework issues to the Cairngorms National Park Board as well as writing policies for the development of the National Park Plan, the Local Plan and writing and producing the Cairngorms Biodiversity Planning Guidance Note.
- Co-ordinated the production, development and implementation of 26 Habitat and 100 Species Action Plans in the Cairngorms on behalf of stakeholder and partner organisations. This covered collaborative biodiversity work on a quarter of the UK's most threatened species.
- Developed, co-ordinated and contributed to seven projects on non-native species: (1) Strategic water vole and American Mink plan for Cairngorms, (2) Developed and implemented Cairngorms non-native fish programme, (3) Investigated impact of non-native Mandarin ducks on native Goldeneyes in Scotland, (4) Seabird conservation and rat eradication, Eynhallow Island, Orkney, (5) Research into non-native *Ranunculus* on freshwater pearl mussels and salmon, (6) Invasive Species in Ireland, (7) UK Overseas Territories invasive species prevention.

Other qualifications:

Full, clean driving licence (Lantra 4 wheel-drive off-road trained). Fully licensed freshwater pearl mussel surveyor. Construction Skills Certification Scheme/ROLO H&S Trained: Professionally Qualified Person (Reg No: 13290751). Fellow of Chartered Institute of Ecology and Environmental Management. Winner of the RSPB's 2014 Nature of Scotland Species Champion Award. Winner of the 2018 Neil Findlay Trophy, Scottish Forestry sectors awards. At the 2018 Chartered Institute of Ecology and Environmental Management (CIEEM) Awards, Peter and Alba Ecology were Highly Commended in the Best Practice Award for Knowledge Sharing.

Computer skills:
Peter is a skilled user of PC desktop systems; using standard packages such as Windows Excel, Word, Powerpoint etc. Peter is proficient in desktop publishing and has edited and published numerous bulletins, newsletters, reports and press releases.

Media and presentation skills:
Peter is highly experienced with all forms of contemporary media, having appeared on dozens of TV and radio programmes, as well as broadsheet and blog media. Peter is a well-respected public speaker and lectures in Great Britain, Ireland and internationally on a variety of conservation topics.

Personal interests and hobbies:
Hill walking and camping, ornithology, fishing, cycling, cricket, football, public speaking and wildlife guiding.

References available on request

Appendix 1: **SCIENTIFIC WRITING**

PEER REVIEWED SCIENTIFIC PUBLICATIONS:

- **Cosgrove, P.** 2024. *Archaeological Discovery – an Ecologist's Perspective from Scotland*. In Practice 125: 62-64. Chartered Institute of Ecology and Environmental Management.

- **Cosgrove, P.** 2023. *Ring Ouzels foraging on Cairngorms snow patches*. Scottish Birds 43: 247.

- **Cosgrove, P.,** Picton, J. and Massey, K. 2023. *Rannoch Brindled Beauty* Lycia lapponaria *in the Flow Country*. Atropos 72: 32-35.

- **Cosgrove, P**., Massey, K., Shields, D. and Anderson, D. 2022. *Conserving breeding goldeneyes in Scotland through nest-box construction*. Conservation Land Management 20: 9-13.

- **Cosgrove, P.,** Shields, D., Anderson, D., Massey, K., Cosgrove, C. and Sime, I. 2022. *The Impact of a drought on key freshwater pearl mussel* Margaritifera margaritifera *populations in Scotland*. Journal of Conchology 44: 1-15.

- **Cosgrove, P**., Shields, D. and Anderson, D. 2021. *Nuthatch colonisation of Glenfalloch Estate, Loch Lomond and the Trossachs National Park*. Scottish Birds 41: 317-319.

- **Cosgrove, P.** 2019. *Black Redstart breeding in the Cairngorms*. Scottish Birds 39:3-7.

- **Cosgrove, P.**, Kortland, K., Shields, D., Potter, R., Murray, J. and Cosgrove, C. 2017. *Response of incubating golden and white-tailed eagles to forest road traffic: results of a pilot study*. Scottish Birds 37: 14-25.

- **Cosgrove, P.,** McInnes, N., Dolby, S., Gunn, D., Shields, D., Cosgrove, C. and Kortland, K. 2017. *Forest management and freshwater pearl mussels: a practitioners' perspective from the north of Scotland.* Scottish Forestry 71: 14-21.

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- **Cosgrove, P**., Watt, J., Hastie, L., Sime, I., Shields, D., Cosgrove, C., Brown, L. Isherwood, I. and Bao, M. 2016. *The status of the freshwater pearl mussel* Margaritifera margaritifera (L.) *in Scotland: extent of change since 1990s, threats and management implications*. Biodiversity and Conservation 25: 2093-2112.

- **Cosgrove, P.** 2016. *Do adult Golden Eagles teach their offspring to hunt?* Scottish Birds 36:10-11.

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- **Cosgrove, P.**, Hastie, L, Watt, J., Sime, I. and Boon, P. 2012. *Scotland's freshwater pearl mussels: the challenge of climate change*. In: River Conservation and Management. Wiley-Blackwell.

- **Cosgrove, P.**, Hastie, L. and Sime, I. 2012. Wildlife Crime and Scottish Freshwater Pearl Mussels. British Wildlife 24: 10-13.

- Jahn, O., **Cosgrove, P.**, Cosgrove, C., Muses Cevallos, T. And Santander Garcia, T. 2010. *First record of Brown Pelican* Pelecanus occidentalis *from the Ecuadorian Highlands*. Cotinga 32: 108.

- **Cosgrove, P.** 2008. *Grenada Dove* Leptotila wellsi *response to non-native ground predators.* Cotinga 30: 72-73.

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- **Cosgrove, P.**, Hastie, L. and Sime, I. 2007. *Recorded natural predation of freshwater pearl mussels* M. margaritifera (L.) *in Scotland.* Journal of Conchology 39: 469-472.

- **Cosgrove, P.J.** and Harvey, P.V. 2005. *The rediscovery of freshwater pearl mussels* Margaritifera margaritifera (L.) *in Shetland*. Shetland Naturalist 2:2 pp 57-64.

- **Cosgrove, P.** and Harvey, P. 2003. *An unusual freshwater pearl mussel* Margaritifera margaritifera (L.) *population in Scotland.* Journal of Conchology 38: 139-146.

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- **Cosgrove, P.** 2003. *Mandarin ducks in northern Scotland and the potential consequences for breeding Goldeneye*. Scottish Birds 24:1 pp 1-10.

- **Cosgrove, P.** and McGregor, R. 2003. Short note: *Unusual behaviour of Common Redshanks and Common Starlings towards dead Common Redshank.* Scottish Birds 24:1 pp 40.

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- **Cosgrove, P.J.** and Hastie, L.C. 2001. *Conservation of threatened pearl mussel populations: river management, mussel translocation and conflict resolution*. Biological Conservation 99:183-190.

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- **Cosgrove, P.** and Oswald, J. 2001. *Capercaillie captures in snares*. Scottish Birds 22: 40-42.

- **Cosgrove, P.J.**, Young, M.R., Hastie, L, C., Gaywood, M. and Boon, P.J. 2000*. The status of the freshwater pearl mussel* Margaritifera margaritifera *Linn. in Scotland*. Aquatic Conservation: Freshwater and Marine Ecosystems 10:197-208.

- Hastie, L.C., Young, M.R., Boon, P.J. **Cosgrove, P.J.** and Henninger, B. 2000. *Sizes, densities and age structures of Scottish* Margaritifera margaritifera *(L.) populations*. Aquatic Conservation: Marine and Freshwater Ecosystems 10:229-247.

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- Alba Ecology, 2020. Cairngorms Crane Project: Feasibility Study for Crane Reintroduction. A commissioned report by Scotland: The Big Picture and the Cairngorms National Park Authority.

- **Cosgrove, P.**, Shields, D., Anderson, D. and Massey, K. 2020. Understanding the impact of the 2018 drought on key freshwater pearl mussel populations in Scotland. SNH Research Report.

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- **Cosgrove, P.** and Shields, D. 2018. Kercock, River Tay Freshwater Pearl Mussel Survey, 2018. Glenprosen Estate Commissioned Report.
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- **Cosgrove, P.**, Hastie, L. and Sime, I. 2012. *Wildlife crime and Scottish freshwater pearl mussels*. British Wildlife 24:1 pp 10-13.
- **Cosgrove, P.** Guest blog 2012: *Mollusc of the Glen*. Standing up for Nature. https://markavery.info/2012/10/29/guest-blog-mollusc-glen-peter-cosgrove/
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CURRICULUM VITAE
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RECENT CAREER SUMMARY

2022-present day	Director of Ecology at Alba Ecology.
2015–2022	Principal Ecologist and Habitat Surveyor with Alba Ecology.
2012 -2015	Senior Ecologist, Alba Ecology.
2010 -2012	Ecologist, Alba Ecology.
2008-2009	Post-doc Researcher, University of Aberdeen.
2007-2008	Biodiversity Officer, Environment Agency

EDUCATION

2003-2007	PhD. Biology and Environmental Science, University of Sussex.
2002-2003	MSc. Ecology, University of Aberdeen.
1998-2001	BSc. (Hons) Environmental Geoscience, University of Bristol.

PROFILE

Kate is a highly experienced ecologist with over twenty years working in ecological research and habitat assessment. Kate is a particularly skilled botanist and respected habitat surveyor. She has contributed to and led on many large projects and has a strong proven track record of delivery in both the public and private sector, producing over 100 commissioned reports and peer-reviewed scientific papers.

Kate's main roles as a Director of Ecology within Alba Ecology is co-ordinating ecological work, providing ecological advice as well as carrying out habitat assessments for a range of projects. Kate leads all the habitat and botanical-based work such as Phase 1 Habitat, National Vegetation Classification (NVC), Groundwater Dependant Terrestrial Ecosystem (GWDTE), Peatland Condition Assessments (PCA) and floristic surveys for protected plants. This habitat assessment work has also been applied to Kate's ornithological studies into the breeding biology and habitats of for example, whimbrel and cranes.

In the last 10 years, Kate has successfully worked on numerous projects in the north of Scotland and has got the vegetation and habitat element of Environmental Impact Assessments accepted on numerous wind farms including Sallachy Wind Farm, Blarghour Wind Farm, Mossy Hill Wind Farm, Bhlaraidh Wind Farm, Beaw Field Wind Farm, Stronelairg Wind Farm, Glencassley Wind Farm and Sallachy Wind Farm with others currently going through the planning/consents process. Kate has written multiple Environmental Impact Assessment Report Ecology chapters and has experience of appearing at Public Inquiry as an expert witness for upland peatland habitats.

Kate is interested in invasive species management and recently led a successful effort to remove non-native American Skunk Cabbage from a tributary of the River Spey Special Area of Conservation. Kate has surveyed for a range of non-native invasive species and has produced management plans to form the bases of control/eradication programs.

RELEVANT EXPERIENCE

Habitats and Vegetation Surveys

Kate has carried out numerous (> 100) Phase 1 Habitat, NVC and GWDTE surveys in a wide range of habitats and vegetation types including uplands, montane area, sand dunes and grasslands. Kate co-ordinates the projects, carries out field work, writes the associated reports and figures. Recent projects include Sallachy Wind Farm, Shetland Space Centre, the new Grantown on Spey whisky distillery, Mossy Hill Wind farm, Lairg Wind farm, Coul Links Golf Course, Viking Wind Farm, Bhlaraidh Wind Farm, Stronelairg Wind Farm, Glencassley Wind Farm plus numerous smaller scale projects (single turbines, housing developments etc).

Ecological Project Co-ordination

Kate has led on the production of the Ecology elements of EIARs for a number of large-scale projects, including chapter writing, technical appendix writing and figure production. Recent projects include the new Shinness Wind farm, Sallachy Wind Farm, Shetland Space Centre, Lairg Wind Farm, Coul Links Golf Course, Mossy Hill Wind Farm and Beaw Field Wind Farm with many still going through the planning process. Kate also co-ordinates all habitat and vegetation projects, including managing field workers, writing report, meeting deadlines and providing advice.

Public Inquiry

Kate has appeared as an expert witness in relation to peatland habitats for Blarghour Wind Farm Public Local Inquiry which was consented in 2021. Kate produced detailed evidence which was found to be robust by the Reporter and Scottish Ministers. Kate has also supported a series of wind farm application that have been objective to by NatureScot on aspects of peatland habitats.

Peatland Restoration

A particular strength is Kate's work on large-scale peatland restoration projects in relation to wind farm developments and Forestry and Land Scotland in the north and west of Scotland. This work has featured strongly in Habitat Management Plans we have developed with our recent clients.

Species Surveys

Kate is experienced in undertaking surveys for a range of rare and/or protected species such as botanical surveys for rare species, otters, water voles, red squirrels and badger surveys. Kate is particularly experienced freshwater pearl mussel surveyor and holds a freshwater pearl mussel licence. Kate has surveyed for this species in numerous rivers, including survey several Special Areas of Conservation (SACs) designated for freshwater pearl mussels.

Ecological Clerk of Works (ECoW)

Kate has contributed to ECoW teams on several projects, including: Cairn Distillery, Beachen Court housing development - Highland, Meikle Carewe Wind Farm – Aberdeenshire, Boat O'Brig bridge repair – River Spey SAC, Moray and LH Stainless industrial development, Keith, Moray.

GIS, Data Handling and Statistical Analysis

Kate is also our GIS specialist and statistics advisor. She is highly skilled in dealing with complex data sets. She has provided the bird Collision Risk Assessments (CRA) for numerous wind farm sites including Shinness Wind Farm, Sallachy Wind Farm, Lairg Wind Farm, Blarghour Wind Farm and Mossy Hill Wind Farm. Kate performs analysis on our ecological data when required, such as modelling bird population dynamics using VORTEX e.g. red kites and red-throated divers.

Kate is proficient in using ArcGIS and QGIS. Her work involves creating, drawing and editing ecological data such as habitat polygons and flightlines as well as producing the maps and figures for EIAR submissions. Kate has a good working knowledge of statistical and data presentation packages such as Minitab, VORTEX and Simgmplot.

RELEVANT SKILLS

Vascular Plants

- Excellent plant identification skills for plants found in grasslands, sand dunes and salt marshes and particularly upland habitats including heaths, mires, flushes and montane habitats.

Non-native Invasive Species

- Excellent identification skills for non-native invasive plant species. Provides surveys for a range of non-native invasive species and produced management plans to form the bases of eradication programs.

Non-vascular Plants

- Good bryophyte identification skills (attended bryophyte identification course, Royal Botanic Gardens, Edinburgh, and *Sphagnum* identification course).

Habitats and Communities

- Highly experienced (>15 years) in Phase 1 Habitat and NVC surveying, including assing peatland condition.
- Highly experienced (>12 years) in assessing potential GWDTE.

Freshwater Pearl Mussels

- Highly experienced freshwater pearl mussel surveyor.

Mammals

- Experienced in following standard guidance and standard survey techniques for a range of mammal surveys and identifying mammal field signs for a range of species (e.g. water voles, otters, badgers, pine marten and red squirrel).

Computer Skills

- Highly skilled user of PC desktop systems; using standard packages such as Windows Excel, Word, Powerpoint etc. Also skilled in GIS software using both ArcGIS and QGIS and statistical packages such as Minitab, VORTEX and Sigmaplot.

Presentational Skills

- Presents e.g. lectures, webinars, conferences as requested.
- Presented scientific research at several conferences such as the British Ecological Society annual conference. Regularly presents information at project team meetings.
- Confident and competent at presenting technical and often complex information at Public Local Inquiry.

OTHER QUALIFICATIONS

Full driving licence. Member of Chartered Institute of Ecology and Environmental Management. Construction Skills Certification Scheme/ROLO H&S Trained: Professionally Qualified Person (Reg No: 13290630; Expires: April 2025). Current First Aid Certificate. Safe Space Certificate.

PERSONAL INTERESTS and HOBBIES

Hill walking, mountain biking and naturalist. Kate also volunteers through Girl-guiding as a Guide Leader running weekly meetings, camps, holidays and activities for young girls and teenagers.

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References available on request

Annie Danskin is a Chartered Environmentalist with over 26 years of experience in the field of air quality consultancy and research, managing projects for and providing introductory and advanced training courses to many local authorities, regulatory authorities (EA, SEPA, HSE), industrial operators and academic institutions. She has taken part in public inquiries and planning hearings and presented at public consultation meetings, conferences, and exhibitions on many occasions.

Key projects include air quality impact assessments for EIAs, planning applications and PPC and Environmental Permits; Local Air Quality Management studies; odour and dust risk impact assessments and management plans; deposition assessments for Habitat Regulations Assessments; and assessment of accidental and emergency releases including fires and flares at offshore and onshore installations including Battery Energy Storage Systems. She is an experienced project manager and is a specialist in atmospheric dispersion modelling, particularly using the full suite of ADMS models.

Annie is a member of the Institution of Environmental Sciences, a committee member of the Institute of Air Quality Management and a member of Environmental Protection Scotland Expert Advisory Group on Air Quality.

Education

- B.Eng. (Hons) Environmental Engineering. University of Strathclyde

Project Experience

Rockets and Space

SaxaVord Space Centre, Lamba Ness, Shetland Islands – Client: Shetland Space Centre**

Technical lead for an air quality impact assessment of a rocket launch facility and preparation of an EIA report chapter. Preparation of a dispersion modelling study to assess the potential short-term effects for local residents of exposure to carbon monoxide emissions from jet exhaust emissions during rocket launch events using an innovative "puff" model technique to calculate peak exposure concentrations during the lifetime of the release and a total concentration dose experienced at each receptor for the duration of release. Launch events were simulated for a range of meteorological conditions. Potential effects of construction and operational vehicle emissions were also included with consideration for effects at ecologically sensitive features.

SaxaVord Space Centre**

Assessment of Environmental Effects (AEE) in support of spaceport operator's licence. Evaluated potential air quality impacts in the context of Assessment of Environmental Effects (AEE) guidance, liaising with Civil Aviation Authority to agree approach and work through post-submission comments and amendments.

Launch Operators (multiple)**

Air Qualityassessments in support of Launch Operator's Licence applications for use of SaxaVord spaceport by launch operators Skyrora, ABL RFA and HyImpulse. Evaluated potential air quality impacts in the context of Assessment of Environmental Effects (AEE) guidance, liaising with Civil Aviation Authority to agree approach and work through post-submission comments and amendments.

**Denotes experience completed at another firm

Rocket Engine Testing Facility, Cockenzie and Broadlaw – Client: Skyrora**

Preparation of a dispersion modelling study to assess the potential short-term effects for local residents of exposure to carbon monoxide emissions from jet exhaust emissions during rocket launch events at a proposed rocket engine testing facility. Used the "puff" model to calculate peak exposure concentrations during the lifetime of the release and a total concentration dose experienced at each receptor for the duration of release. Launch events were simulated for a range of meteorological conditions.

Renewables/Energy Transition

3 x 400 MW Battery Energy Storage Systems – Clients: Confidential**
Technical Lead and developer of method to assesses the potential impacts on human health and ecological receptors of fires at BESS sites caused by battery failure and thermal runaway events. Calculations to determine the plume height and opacity at a range of distances downwind from the fire and a range of elevations to inform Fire and Rescue services about areas to evacuate and identify possible restrictions on access routes/requirement for additional routes. Local topography and meteorology were used to predict downwind concentrations of toxic gases for comparison with a range of environmental assessment levels and workplace exposure limits to contextualise the risk of exposure of the wider local population to harmful levels of pollution. The deliverable is a report that can be used to influence the proposed development design and inform an emergency response plan as recommended by the National Fire Chief Council guidance.

Caledonia Offshore Wind Farm – Client: Ocean Winds**
Technical lead and author of Scoping Chapter assessing the potential effects on air quality of the construction of the onshore infrastructure construction phase including landfall options, cable routes and substation locations. The assessment included consideration of drilling methods, construction phase traffic emissions and non-road mobile plant (NRMM) exhaust emissions.

Project Erebus Floating Offshore Windfarm – Client OWC**
Technical lead and author of Scoping and ES Chapter assessing the potential effects on air quality of the construction of the onshore infrastructure construction phase including landfall options, cable routes and substation locations. The assessment included consideration of construction phase traffic and non-road mobile plant (NRMM) exhaust emissions.

Seagreen 2/3 (Berwick Bank) Offshore Windfarm – Client SSE**
Technical lead and author of EIA scoping report chapter assessing the potential for effects on air quality of the construction of the onshore infrastructure construction phase including landfall options, cable routes and substation locations. Air Quality effects scoped out of EIA.

Richborough Energy Compensator – Client: Barton Willmore now Stantec**
Construction Dust Risk Assessment and Site suitability study for the construction and operation of a grid stability facility located adjacent to the Southern Water Weatherlees Hill Wastewater Treatment Works, in Richborough, within the Thanet District Council (TDC) Local Authority Area.

Peaking Power Plants – Client: Forsa Energy**
Technical advisor on detailed stack height analysis and dispersion modelling assessments of peaking power plants in Dundee and Greenock including assessment applications for Medium Combustion Plant Directive permits. The study for one site included consideration of the potential impacts of existing nearby wind turbine wakes on the dispersion of emissions from the new PPP stacks.

Glasshouse, River Source Heat Pump and Associated Infrastructure – Client: Bandeath Holdings Ltd**

Project Manager on air quality assessment for planning application. Included assessment of emissions from gas CHP with CO_2 capture for circulation in tomato greenhouses. Included dispersion modelling and the development of management plans to minimise emissions to atmosphere from the operation of the plant.

Industrial & Manufacturing

Addenbrooke's Hospital Incinerators, Cambridge – Client: Cambridge University Hospitals NHS Foundation Trust

Project Director on study including dispersion modelling and human health risk assessment (HHRA) of emissions of dioxins and furans from the hospital clinical waste incineration plant. The study is required by the Environment Agency (EA) to confirm that the maximum predicted Tolerable Daily Intake (TDI) level is below the guidance level of 2 pg/kg-bodyweight/day, while abatement technologies are being developed to reduce emissions below the permitted emission limit value. Includes detailed topography and a bespoke buildings model for the Addenbrookes site.

Electric Arc Furnace, Teesside – Client: British Steel Limited**

Preparation of an ES Air Quality Chapter submitted with the planning application. The Air Quality Impact Assessment (AQIA) included a detailed atmospheric dispersion modelling study to assess the potential impacts of emissions from a proposed new electric arc furnace and its associated traffic generation at sensitive receptors for human health and ecology. Included deposition calculations to inform a Habitats Regulations Assessment. Involved extensive consultation with EA, Borough Council and Natural England.

Alloy Wheel Facility, Lochaber – Client: Liberty Lochaber Aluminium Ltd**

Preparation of an EIA Report Air Quality Chapter submitted with the planning application. The Air Quality Impact Assessment (AQIA) included a detailed atmospheric dispersion modelling study to assess the potential impacts of emissions from a proposed new alloy wheel facility and adjacent biofuel generators at sensitive receptors for human health and ecology. Included deposition calculations to inform a Habitats Regulations Assessment. Included complex topography, building effects, time-varying emissions profiles and a range of operating scenarios and meteorological conditions. Involved extensive consultation with SEPA, SNH and The Highland Council. Assessment included a Construction Phase Dust Risk Assessment.

Aluminium Smelter, Lochaber - Client: Liberty Lochaber Aluminium Ltd**

This AQIA study included predictions of concentrations of gaseous HF within and outside the cell room buildings during normal operating conditions and in two power failure scenarios. The study used monitored concentrations of HF collected from the Fume Treatment Plant stacks and at the cell room roof vents, in conjunction with data from the latest report on Fluoride Pot Evolution to develop a dispersion model using the latest version of atmospheric dispersion modelling software, ADMS 5. The study was required as part of the site COMAH Predictive Risk Assessment for the UK Health & Safety Executive.

Hillthorn Business Park, Sunderland – Client: Legal & General**

Technical lead for an air quality impact assessment of a large industrial business park and preparation of an ES report chapter. The air quality assessment included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors included ecologically sensitive site. Assessment included a Construction Phase Dust Risk Assessment and cumulative assessment with several significant development projects in the local area.

**Denotes experience completed at another firm

New boiler installation, Rainham – Client: Sharpsmart Limited**

Technical lead for an air quality assessment and habitats risk assessment to accompany an application to the Environment Agency for a variation to an Environmental Permit for a new boiler installation. Included detailed dispersion modelling and calculations of nutrient nitrogen deposition and total acid deposition at a range of international and local designated sites in accordance with guidance AQTAG06 – under the Habitats Regulations.

Coffee Roasting Factory, Dundee – Client: Aimers Coffee & Tea**
Preparation of a detailed dispersion modelling study of emissions of odour, dust, and oxides of nitrogen from a new coffee roasting factory in Dundee. Included analysis of a range of conditions dependent on the raw coffee bean source and the darkness of roasting. Included complex topography, sensitivity to building effects, time-varying emissions profiles and a range of operating scenarios and meteorological conditions. Involved extensive consultation with Dundee City Council.

Rosebank, Islay, Jedburgh and Invergordon Distilleries, Glenrothes and Glenmorangie Warehousing – Client: Blyth and Blyth**
Stack height optimisation calculations, screening of boiler emissions, odour risk assessments and development of odour management plans.

Oil & Gas

Armada Kraken FPSO Vessel – Client: PI Ltd**
Technical lead for assessment required to support an application to operate the vessel under Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2001. The purpose of the assessment was to predict pollutant concentrations of key substances at the nearest platforms within the North Sea, human receptors on the vessel and the nearest inhabited landfall point. The assessment considered the atmospheric emissions from the installation during normal gas and crude oil operations of the Steam Boiler Package (SBP) and the Power Generation Module (PGM).

Montrose Alpha Offshore Installation – Client: PI Ltd**
An assessment of atmospheric emissions from the existing installation and additional sources on a new bridge linked platform (BLP) adjacent to the Montrose platform, required to support an application to vary the PPC permit for the installation.

Brent Removal and Dismantlement – Client: Shell (UK) Ltd**
Management and technical delivery of Air Quality Environmental Statement chapter for the EIA to address the potential effects of the Brent Delta topside transfer to barge, inshore transit, and onshore dismantlement project on air quality in Hartlepool.

BAT Assessment of Odour Abatement Options and Odour Management Plan for PPC Compliance at Nigg Terminal**
Review of potential odour emission sources on-site including jetty operations, ship-to-ship transfer, crude oil reception and separation, ballast tanks, API separators, settlement tanks and lagoons and recommendations for priority control. The study included a BAT assessment of options for odour control and abatement and the development of new management procedures.

Property & Urban Regeneration

Old Tynecastle High School, Edinburgh – Client: S1 Developments**
Project Director for the delivery of noise and air quality assessments for a planning application for heavily constrained site. Included monitoring and modelling of noise, air and odour emissions from a neighbouring industrial site, an elevated road source, a football stadium and social club. Included extensive consultation correspondence with the Environmental Health Officer and providing recommendations for mitigation in the design. Application went to appeal

**Denotes experience completed at another firm

and was approved by the Scottish Government Report. Summary statements were provided for the appeal process.

PBSA South Ward Road Dundee – Client: The Lotus Group**
Technical Lead for the development of a methodology to assess the potential impacts of odour from existing nightclub and takeaway venues on future occupants of a purpose-built student accommodation development. Included the creation of a building-effects model and multiple scenario testing including exhaust ventilation rates, hours of operation and variable meteorological conditions. Extensive correspondence with the EHO and Mechanical and Electrical Engineers on the project. Planning approval was achieved after the presentation of a mitigation plan for seven bedrooms predicted to have an elevated exposure to odour compared with that experienced by existing residential properties without the Proposed Development in place.

Cammo Fields Residential Development, Maybury Road, Edinburgh – Client: Cala Homes**
Technical lead for an air quality impact assessment of a residential development and preparation of an EIA report chapter. The air quality assessment included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors including a large number of projected cumulative impacts from allocated development sites included in the West Edinburgh Transport Appraisal (WETA). Additional assessment of impacts was undertaken within a nearby AQMA. Supplementary reports including an assessment of the potential for odour impacts from a nearby composting facility. Summary statements were prepared for a City of Edinburgh Council planning hearing.

Edinburgh Park Southern Phase, Residential-Led Mixed Use Development, Edinburgh – Client: Parabola Edinburgh LLP**
Technical lead on an air quality impact assessment of a residential-led mixed-use development. Included dispersion modelling with ADMS-Roads to predict the potential effects of traffic-generated pollutants on air quality at existing and proposed receptors including a large number of projected cumulative impacts from allocated development sites included in the West Edinburgh Transport Appraisal (WETA). Additional assessment of impacts was undertaken within two nearby AQMAs. A comprehensive six-month ambient air quality monitoring survey was also undertaken at locations around the proposed development boundary, and the data used to verify the dispersion model. The study also included an odour risk assessment due to the proximity of the proposed development to a poultry farm and included several odour sampling surveys in a variety of meteorological conditions and operational scenarios at the poultry farm.

Johnnie Walker Experience, Edinburgh – Client: DIAGEO**
Air quality impact assessment of a visitor experience development including the potential effects on local air quality of development-generated traffic, combustion source emissions and kitchen extraction systems at existing and proposed receptors including within the adjacent Edinburgh Central AQMA.

Clyde Waterfront & Renfrew Riverside and Glasgow Airport Improvement Area City Deals Projects- Client: Renfrewshire Council **
Senior team member to undertake air quality impact assessment of both schemes individually and assess the cumulative impact of both in conjunction with development projected to be facilitated by the Proposed Development. Including advanced dispersion modelling and GIS techniques and extensive data management. Preparation of material for public exhibitions and culminating in the production of three separate Environmental Statement Chapters on Air Quality with detailed technical appendices plus contributions to Climate Change chapters.

**Denotes experience completed at another firm

Corporate Advisory

Review and Assessment of Air Quality for Local Authorities**
Project Manager for a series of assessments for Scottish Local Authorities required as part of the Local Air Quality Management regime implemented under the Environment Act 1995. Included collation of emissions inventories including industrial, commercial, domestic and road traffic sources across the Council areas and within hotspots and Air Quality Management Areas (AQMAs); detailed regional-scale dispersion modelling studies to determine source contributions and inform Action Plans for improvement; lead stakeholder engagement events; advise on air quality monitoring campaigns and preparation of annual reports. Peer review of AQIAs submitted with planning applications regularly provided for multiple Local Authorities.

Memberships and Associations

- CEnv - Chartered Environmentalist
- Member Institution of Environmental Sciences
- Committee Member Institute of Air Quality Management
- Member of Environmental Protection Scotland Expert Advisory Group on Air Quality

Publications

- Validation of ADMS Against Wind Tunnel Data of Dispersion from Chemical Warehouse Fires, Carruthers D.J., McKeown, A.M. (now Danskin), Hall D.J and Porter S, (Atmospheric Environment. Vol 33 (1937-1953), 1999).
- The Role of Atmospheric Dispersion Modelling in Local Air Quality Management: Applications, Limitations and Lessons Learned, Annie Danskin (CIWEM Conference 2003)

**Denotes experience completed at another firm

Simon Waddell, BSc (Hons) MIOA
Associate | Acoustics | Remote

SLR

Simon is an experienced environmental consultant, with over 18 years' experience, 13 years of which he has specialised in environmental noise. A technical specialist in environmental noise, but with an appreciation of other environmental disciplines, Simon has extensive experience of noise assessment in accordance with various planning and permitting requirements across the UK, particularly in relation to power generation, energy storage, infrastructure, residential, industrial and waste-related developments.

Simon also has substantial international ESIA experience to both local and international standards, including IFC/World Bank, predominantly in relation to mining and power generation. His ESIA experience includes the specification, commissioning and analysis of baseline monitoring campaigns and development of noise source inventories and computational models to international standards to determine potential environmental effects.

Education

- BSc (Hons) Environmental Geoscience. University of Edinburgh
- Postgraduate Diploma Acoustics and Noise Control
- Certification of Competence in Environmental Noise Measurement

Selected Project Experience

UK Project Management – Rockets and Space

Midlothian, Scotland**

Project managed multi-disciplinary environmental support to planning application for rocket engine testing facility within former quarry in the Moorfoot Hills. Client liaison, meetings with planning officers, coordinated team and provided post-submission support to client.

UK Noise – Rockets and Space

SaxaVord Space Centre, Unst, Shetland**

Noise assessment of proposed spaceport. Undertook baseline noise survey, predicted construction phase noise levels, liaised with rocket and aircraft noise specialist, interpreted prediction in the context of UK guidance, liaised with ecologists/ornithologists and cultural heritage specialists regarding noise/vibration effects on nonhuman receptors and reported on findings. Planning permission secured. On-going project support following planning consent.

SaxaVord Space Centre**

Assessment of Environmental Effects (AEE) in support of spaceport operator's licence. Evaluated potential noise impacts in the context of AEE guidance, liaised with Civil Aviation Authority to agree approach.

Launch Operators (multiple)**

Noise assessments in support of Launch Operator's Licence applications for use of SaxaVord spaceport by launch operators Skyrora, ABL and RFA. Evaluated potential noise impacts in

**Denotes experience completed at another firm

the context of Assessment of Environmental Effects (AEE) guidance, liaised with Civil Aviation Authority to agree approach and work through post-submission comments and amendments.

Midlothian, Scotland**

Noise assessment in support of proposed rocket engine testing facility. Baseline noise survey, agreement of approach with Environmental Health, prediction of operational noise levels, evaluation against agreed criteria.

Midlothian, Scotland**

Noise compliance measurements during rocket engine tests; measurement of operational noise levels at off-site locations, reported on measured levels and demonstrated compliance with planning conditions. On-going operational support; measurement of source level of rocket engine plume and source vibration levels at locations on the engine testing stand.

Cockenzie, East Lothian, Scotland**

Noise and assessment as part of planning application for operation of proposed rocket engine testing facility within former power station coal storage area. Consulted with Environmental Health, undertook baseline noise survey, predicted operational noise levels via noise modelling, evaluated in accordance with BS4142 and appropriate guidance, attended community consultation events, specified appropriate mitigation, reported on findings.

Port of Rosyth, Fife, Scotland**

Measured noise levels during test firing of a rocket engine. Postprocessed measured data to determine sound power level of test and characterise noise emissions associated with testing activities.

UK Noise - Power

Caledonia Offshore Wind Farm**
Noise chapter of EIA for onshore cable corridor and onshore substation. Undertook consultation with Aberdeenshire Council, supervised baseline survey and data analysis, predicted construction and operational phase noise levels, evaluated against agreed criteria, provided noise chapter of EIA report.

East Anglia One North**
Operational on site noise survey, using a Sound Intensity Meter, to ascertain precise sound emissions from operational electrical equipment, including transformers and harmonic filters, within the onshore substation and provide concurrent noise monitoring surveys at local off-site sensitive receptors. The Sound Intensity Meter measurements were used to refine the noise modelling undertaken for the substation to predict noise levels at these nearby sensitive receptors and provide reporting to the client to satisfy DCO requirements for the compliance with approved noise conditions on Nationally Significant Infrastructure Project NSIP.

Battery Energy Storage Systems (BESS); **

Many locations across England, Wales and Scotland for numerous clients. Provision of initial site selection and layout advice, preliminary modelling and recommendations, baseline noise surveys, consultation with Environmental Health, including detailed negotiation of appropriate noise limits, modelling, evaluation and reporting in support of planning applications. Detailed mitigation modelling through iterative process to achieve noise limits. Development of a library of sound power levels for different battery technology providers. Noise surveys of operational BESS developments to characterise ‘real world’ source noise levels and characteristics.

Solar farms; multiple locations and clients**

Noise assessments in support of proposed solar developments to confirm compliance with appropriate criteria, including both BS4142 and noise rating (NR) criteria. Specification of minimum stand-off distances between noisy plant and neighbouring residential properties. Provision of noise chapter to EIA Reports for larger developments.

Wind farms**

Simon has over 12 years' experience in wind farm noise. He has worked on many projects for numerous clients covering every stage from feasibility studies, EIA Screening and Scoping inputs, EIA Chapters, drafting and review of proposed planning conditions, mitigation studies and discharging planning conditions, plus a wide range of other technical support inputs. Many of the projects have involved detailed review of information relating to existing cumulative developments and derivation of appropriate and robust site-specific noise limits. A selection of projects worked on is provided below.

West Andershaw Wind Farm, South Lanarkshire. **

Complex assessment including consultation with neighbouring developer and their consultants to agree approach to cumulative noise assessment. Screening of measured baseline data to exclude noise from neighbouring existing wind turbines. Derivation of residual noise limits in complex cumulative situation.

Nisthill Wind Farm, Orkney**

Assessment in support of proposed wind farm on Orkney Mainland. Consulted with Council to agree approach to assessment, undertook baseline noise survey, analysed baseline noise and wind speed data, predicted operational noise levels, evaluated proposed development's ability to meet derived noise limits and completed detailed cumulative noise assessment, including specification of mitigation to enable noise limits to be met.

Lethen Wind Farm, Highlands**

Assessment in support of proposed wind farm north of Grantown-on-Spey. Consulted with Council to agree approach to assessment, undertook baseline noise survey, analysed baseline noise and wind speed data, predicted operational noise levels, evaluated proposed development's ability to meet derived noise limits and screened for potential cumulative effects, reported on findings.

Harelaw Wind Turbine, East Renfrewshire**

Assessment in support of application for renewed planning consent (where consent had lapsed) for single wind turbine affected by cumulative developments following original consent. Consulted with Council and Council's appointed external consultant to determine approach and identify cumulative developments. Derived residual noise limits for turbine from cumulative noise limits. Predicted operational noise levels and evaluated against criteria, reported on findings.

Sallachy Wind Farm, Highlands**

Provided technical oversight of noise assessment process and full technical review of noise assessment prior to submission.

Orkney Islands Council wind farms (Hoy, Faray and Quanterness)**

Noise assessments in support of three proposed wind farms in Orkney. Consulted with Orkney Islands Council to agree approach to assessment, undertook baseline noise survey, analysed baseline noise and wind speed data, predicted construction and operational noise levels, evaluated proposed development's ability to meet derived noise limits and apportioned noise

**Denotes experience completed at another firm

limits to address cumulative developments consented noise limits and reported on findings as chapter of an the EIA.

Broken Cross Wind Farm, South Lanarkshire**

Noise assessment in support of variation to consented development to revised layout and turbine type. Consulted with South Lanarkshire Council to agree approach to assessment. Undertook updated baseline monitoring, characterisation of baseline noise environment and derivation of noise limits, analysis of revised proposed development's ability to meet derived noise limits and apportioned cumulative noise limits. Supplementary consultation and discussion with South Lanarkshire Council to agree appropriate noise conditions. Follow-up input to discharge planning condition for construction noise assessment.

Energy Isles Wind Farm, Shetland, UK**

Noise assessment in support of proposed wind farm on Yell. Consulted with Shetland Islands Council to agree approach to assessment, undertook baseline noise survey, analysed baseline noise and wind speed data, predicted construction and operational noise levels, evaluated proposed development's ability to meet derived noise limits and noise limits of identified cumulative wind farm and reported on findings. Consulted with Shetland Islands Council with regard to proposed noise conditions for development.

Dalquhandy Wind Farm, South Lanarkshire, UK**

Post-consent curtailment study to address planning condition. Undertook detailed directional predictions to determine compliance with consented cumulative noise limits and provided curtailment strategy demonstrating predicted compliance with noise limits.

Dalquhandy Wind Farm, South Lanarkshire, UK**

Noise assessment in support of variation to consented development to larger model of turbine. Consulted with South Lanarkshire Council to agree approach to assessment and scope out further baseline monitoring. Detailed review of changes to cumulative noise environment (new and revised cumulative developments). Analysis of revised proposed development's ability to meet consented noise limits and cumulative noise limits. Supplementary consultation and discussion with South Lanarkshire Council to agree appropriate noise conditions.

Mains of Hatton Wind Farm, Aberdeenshire, UK**

Noise assessment to determine compliance with planning conditions. Consulted with Aberdeenshire Council, set up noise, wind speed and rainfall monitoring equipment at site. Analysed resultant data and prepared report on findings, demonstrating compliance with the noise limits.

Peaking Power Plants, UK various**

Noise assessment of gas-fired peaking plants comprising multiple gas engines at numerous sites across Scotland, England and Wales. Typically comprising consultation with Environmental Health, undertaking or overseeing the baseline noise survey, analysis of baseline data, prediction of operational noise by detailed modelling, BS4142 assessment and specification of appropriate mitigation if required.

UK Noise – Manufacturing and Waste

British Steel – Teesside Electric Arc Furnace**

Consultation, analysis of baseline data, review of technical design information, modelling of operational noise, evaluation in accordance with BS4142 and production of noise assessment as a Chapter in the EIA report.

Lochaber/Fort William, Highlands, Scotland**

Noise assessment of proposed aluminium billet plant within Lochaber smelter complex. Consulted with SEPA, undertook baseline noise survey, predicted construction phase and operational phase noise levels. Evaluated predicted levels in accordance with BS5228 and BS4142, specified appropriate mitigation and reported on findings as a chapter within an EIA Report.

Hillthorn Farm, Sunderland, England**

Noise and vibration assessment of proposed business park adjacent to Nissan assembly plant. Consulted with Sunderland City Council, specified baseline monitoring campaign, predicted construction phase and operational phase noise levels, including noise from road traffic. Evaluated predicted levels in accordance with BS5228 and BS4142 and against DMRB criteria, specified appropriate mitigation and reported on findings as a chapter within an EIA Report.

Winfrith, Dorset, UK**

Noise assessment as part of EIA of construction and operation of proposed concrete batching plant associated with decommissioning of former nuclear test reactor. Consulted with Environmental Health, undertook baseline noise survey, predicted operational noise levels via noise modelling, evaluated in accordance with BS5228 and BS4142, specified appropriate mitigation, reported on findings.

Tennents Wellpark Brewery, Glasgow, UK**

Noise assessment to meet SEPA requirement for baseline monitoring before commissioning of new anaerobic digestion plant within existing brewery complex. Oversaw baseline noise survey, technical review of noise report.

IAMP TWO, Sunderland, UK**

Noise assessment as part of EIA for large-scale multi-unit manufacturing complex. Contributed to Scoping and undertook detailed consultation with Environmental Health. Undertook baseline noise survey, predicted noise levels during construction and operation of the facility, and due to changes in road traffic flows. Vibration assessment considering vibration from piling and from road traffic.

IAMP ONE, Sunderland, UK**

Noise assessment as part of EIA for large-scale multi-unit manufacturing complex. Contributed to Scoping and undertook detailed consultation with EHO. Undertook baseline noise survey, predicted noise levels during construction and operation of the facility, and due to changes in road traffic flows. Specified appropriate mitigation and reported findings. Proposed development was consented, and is under construction.

SNOP, IAMP ONE, Sunderland, UK**

Detailed noise assessment of the first industrial unit constructed within the IAMP ONE manufacturing complex. Consulted with EHO, constructed detailed noise model of proposed building, using details provided by the construction contractor, determined that the facility would meet its proportionate share of the wider IAMP ONE cumulative noise limits.

Ardross Distillery, Highlands, UK. **

Noise assessment for proposed whisky distillery. Consulted with EHO, reviewed baseline noise data provided by others, reviewed available information and developed noise model of proposed distillery, operations phases in accordance BS4142, specified appropriate mitigation and reported findings.

UK Noise – Land Development

Giants on the Quayside (Whey Aye Wheel), Newcastle-upon-Tyne, UK**

Noise and vibration assessment of proposed observation wheel and associated entertainment facilities as part of EIA. Input to Scoping and consultation with Environmental Health, specified and oversaw baseline noise survey, analysed baseline data, predicted construction noise and vibration levels at sensitive receptors, predicted operational noise levels due to operation of wheel and associated facilities and from changes road traffic flows. Evaluated noise and vibration impact in accordance with BS5228, BS4142 and CRTN, specified appropriate mitigation, reported on findings.

Memberships and Associations

- Member of Institute of Acoustics (MIOA)

Additional Training

- BORDA off road driving training
- Outdoor first aid training

Dr. Liam Dickson

Managing Marine Consultant - Ecology

Liam is a managing marine consultant in the Ecology group at ERM. He has worked across a range of sectors, including offshore renewables, oil and gas, and the UK space industry. His experience includes authoring of marine mammal EIA and ESIA chapters, Scoping Reports, and EPS risk assessments for offshore wind projects across England, Wales, Scotland, Ireland, and abroad. He has also authored environmental appraisals for decommissioning projects, and EAJs for geophysical surveys for North Sea oil and gas projects.

EXPERIENCE: 6 years' experience in consultancy and marine academia

LINKEDIN: https://www.linkedin.com/in/liam-dickson/

EMAIL: liam.dickson@erm.com

EDUCATION

- Doctor of Philosophy, Marine Spatial Ecology
- Master of Science, Marine Environment and Resources
- Bachelor of Science (Honours), Wildlife Biology

FIELDS OF COMPETENCE

- Assessments of Environmental Effects (AEE)
- Environmental Appraisal (EA) and Environmental Assessment Justification (EAJ) reports
- Environmental assessment (EIA and HRA)
- European Protected Species (EPS) risk assessments, licensing and legislation
- Basking shark risk assessments, licensing and legislation
- Nature conservation legislation and policy

KEY INDUSTRY SECTORS

- Aerospace (Marine and Transboundary)
- Renewable Energy (Offshore wind)
- Oil and Gas

PUBLICATIONS

- Dickson, L.C., Katselidis, K.A., Eizaguirre, C., Schofield, G. Incorporating Geographical Scale and Multiple Environmental Factors to Delineate the Breeding Distribution of Sea Turtles. Drones 2021, 5, doi:10.3390/drones5040142.

- Schofield, G., Dickson, L.C., Westover, L., Dujon, A.M., Katselidis, K.A. COVID‐19 disruption reveals mass‐tourism pressure on nearshore sea turtle distributions and access to optimal breeding habitat. Evolutionary Applications 2021, doi:10.1111/eva.13277.
- Dickson, L.C., Tugwell, H., Katselidis, K.A., Schofield, G. Aerial drones reveal the dynamic structuring of sea turtle breeding aggregations and minimum survey effort required to capture climatic and sex-specific effects. Frontiers in Marine Science 2022. doi:10.3389/fmars.2022.864694
- Schofield, G., Papafitsoros, K., Chapman, C., Shah, A., Westover, L, Dickson, L.C., Katselidis, K. More aggressive sea turtles win fights over foraging resources independent of body size and years of presence. Animal Behaviour 2022. doi: 10.1016/j.anbehav.2022.05.006

KEY PROJECTS

Rocket Factory Augsburg Assessment of Environmental Effects (AEE)

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

HyImpulse AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

ABL AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

ILOT AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

Skyrora AEE

Author of Marine and Transboundary chapter, follow-up consultation with CAA and requests for information (RFI)

SaxaVord Spaceport AEE

Co-author of Marine and Transboundary chapter, revisions and requests for information

bp FLORA and bp MORVEN OWF EPS License Risk Assessments

Author of EPS license Risk Assessments, including basking shark impact scoping.

Celtic Sea Array OWF EIAR Scoping Report

Author for Marine Mammals and Megafauna chapter

White Cross OWF EIA

Co-author for Fish & Shellfish, and Fisheries chapters.

Northland EPS and Basking Shark Risk Assessment Review

Review of methodology and data outlined in the EPS and Basking Shark Risk Assessment for geophysical surveys, produced by SMRU for Northland Power.

Peter Dunmow BA(Hons) DipLA MA(Hons)

Chartered Landscape Architect

Qualifications

BA (Hons) Landscape Architecture, Greenwich University, 1991

Dip LA, Landscape Architecture, Greenwich University, 1993

MA (Hons) Landscape Architecture, Greenwich University, 1996

Affiliations

Chartered Member of the Landscape Institute

Fields of Competence

Peter has thirty years of experience in Landscape Architecture and Urban Design, managing and working on a range of projects throughout the UK and overseas. His experience covers the full range of landscape consultancy services including landscape and visual impact assessments, comprehensive planning supporting statements and public inquiry evidence for a range of developments including wind farms and other renewable developments, overhead power lines, substation projects, biomass plants, business parks, housing, roads, quarry and mineral developments. Peter has prepared a range of townscape assessment work for a variety of new retail, commercial and residential developments as well as analysis and survey for urban renewal, regeneration and design studies. In addition, Peter complements these skills with considerable experience in masterplanning, detailed site planning and contract management.

Career History

HEPLA - Hermitage Environmental Planning and Landscape Architecture Limited

Director 2015

Enviros Consulting/ SKM Enviros/ Jacobs

Landscape Technical Lead 2005 – 2015

Farningham McCreadie Partnership

Principal Landscape Architect 1999 - 2005

Chris Blandford Associates, Sussex

1994 - 1999 Landscape Architect

British Waterways, Northamptonshire

Assistant Landscape Architect 1991 - 94

Technical Skills

- Expert Witness
- Landscape and Visual Impact Assessment
- Environmental Impact Assessment
- Masterplanning
- Urban Design
- Townscape Studies and Assessments
- Landscape Design and Implementation

Management Skills

- Organisation and Motivation
- Team Management
- Technical Leadership
- Commercial Focus
- Market Adaption
- Project Management
- Contract Management

Relevant Experience

Public Inquiries

- Pencloe Wind Farm Inquiry (2017) – Provision of support Inquiry Team on landscape and visual matters including preparation of an updated cumulative landscape and visual impact assessment, input to the Inquiry Report and Precognition, cross examination strategy. Appeal allowed. (North British Wind Energy/Invenergy)
- Fallago Rig Extension Inquiry (2017) –Preparation of Inquiry Report, Precognition and acted as Landscape Expert Witness at this wind farm Inquiry, held in the Scottish Borders. Appeal determined based landscape evidence. (Scottish Borders Council)
- Kentish Flats Offshore Wind Farm Extension - Preparation of submissions to the Examination in Public (Vattenfall)
- Inverness Local Plan Inquiry – Preparation of a Statement of Evidence and accompanying documents in support of an allocation for residential development, including attendance and presentation of evidence at Inquiry. (William Gray Construction)
- Shawfair Local Plan Inquiry - Preparation of a Statement of Evidence including an independent Landscape and Visual Impact Assessment of the 'South East Wedge' area of Edinburgh for presentation at a Local Plan Inquiry with specific reference to housing land allocations. (Edmonstone Developments Ltd)
- Dungannon and South Tyrone Local Plan Inquiry - Preparation of Statements of Evidence including Landscape and Visual Impact Assessments of various subject lands for presentation at a Local Plan Inquiry with specific reference to housing/business land allocations. (Dungannon and South Tyrone Borough Council)
- Shawfair Local Plan Inquiry - Preparation of a Statement of Evidence including a supporting Landscape and Visual Impact Assessment for presentation at a Local Plan Inquiry with specific reference to housing land allocations. (Bett Homes Ltd)

Planning Appeals

- Dell Wind Farm – Preparation of landscape and visual aspects of the Statement of Appeal and associated appendices. (Coriolis Energy Limited)
- Article 33 Inquiry - Campbell College, Belfast - Preparation of Statements of Evidence in support of proposed residential developments including supporting Landscape and Visual Impact Assessments and full and detailed mitigation strategies for presentation at an Article 33 Planning Inquiry. (Campbell College Board of Governors)
- London Road, Kilmarnock - Preparation of a Townscape and Visual Impact Assessment in support of the conversion of a former nursing home, forming part of a written submission to the Scottish Executive, Planning and Conservation Area Consent Appeal . (Silverdale Developments Ltd)
- St. Patrick's Church, Cowgate — Preparation of Townscape and Visual Impact Assessment in support of a hotel development in the Edinburgh Old Town Conservation Area forming part of a written submission to the Scottish Executive, Planning and Conservation Area Consent Appeal.
- Straid Road, Ballycastle – Preparation of statement of evidence and documents in support of a small residential development, including attendance and participation in an informal hearing. (Private Client)

Presentations, Consultation and Lecturing

- Delivery of lecture to the MSc / Diploma Postgraduate Course in EIA – Landscape and Visual impact Assessment in EIA, Scottish Rural College. (2020)
- All Energy Conference Paper, Aberdeen, June 2013 – 'Cumulative Assessment – Visualisation Techniques'. Peter set out a review current best practice in the use of graphics to support the cumulative assessment of wind farms.
- Renewables UK Conference Paper, Glasgow, November 2010 – 'Views from the Front: Residential Visual Amenity and Settings Assessment'. Peter set out a user friendly guide to the evolving methodologies for the presentation of robust assessments.
- Provision of EIA module lecturing to the MSc/PG Dip in Ecological Economics – Introduction to Landscape and Visual impact Assessment lecturing role with the Scottish Agricultural College. (2009-2011)
- Scottish Government Planning Advice - Enviros Consulting Ltd MacRoberts LLP were appointed by the Scottish Government to provide support and advice including landscape advice to planning authorities on the preparation of their supplementary planning guidance (SPG) for wind farms from the period between March 2008 and March 2009. Details at www.spgadvice.co.uk. (Scottish Government)
- British Wind Energy Association - Enviros Consulting Ltd were appointed by BWEA to undertake a review of Draft Supplementary Planning Guidance (SPG) Wind Energy in Northern Ireland's Landscapes, prepared on behalf of the Department of the Environment NI by Julie Martin Associates. This review was prepared to assist BWEA in drawing up a formal response to the Draft SPG. (BWEA)

Landscape and Visual Impact Assessments

A wide experience on a very wide range of assessment work including Environmental Impact Assessment, and Landscape and Visual Impact Assessment for over 20 onshore and offshore wind farms. LVIA experience includes preparation of comprehensive planning supporting statements and public Inquiry evidence for a range of developments including business parks, housing, roads, quarry and mineral developments.

Launch Facility and Testing EIA/AEE Experience

- Shetland Space Centre, Unst, Shetland – Preparation of landscape and visual impact assessment for the proposed launch facility at Lamba Ness, section of new road and association launch control buildings on northern Unst – (Shetland Space Centre)
- Shetland Space Centre, Unst, Shetland – Preparation of an Assessment of Environmental Effects for the proposed launch facility for submission to the Civil Aviation Authority – (Shetland Space Centre)
- Shetland Space Centre, Unst, Shetland – Preparation of landscape and visual impact assessment for the installation of new radomes at Baltsound Airport – (Shetland Space Centre)
- Preparation of correspondence to the Civil Aviation Authority for multiple launch operators relating to the scope of the Shetland Space Centre Assessment of Environmental Effects.
- Preparation of a Landscape and Visual Appraisal to support the proposed extension to the airport and installation of new radar radomes at Baltasound, Unst - (Shetland Space Centre)
- Rocket Engine Testing Facility, Broadlaw Quarry, Midlothian – Preparation of landscape and visual impact assessment for a small-scale engine testing rig – (Skyrora)

Renewables Experience

- Pencloe Wind Farm Extension, New Cumnock, East Ayrshire – Preparation of a Landscape and Visual impact Assessment for a proposed 5 turbine extension to the Pencloe Wind Farm, Section 36c application (Invenergy)
- Kilmux Solar Farm, Kennoway, Fife - Landscape and Visual Impact Assessment for a proposed 59 Hectare solar farm on farmland to the north of Kilmux Farm and House (Green Energy International)
- Longmuir Rigg Wind Farm – Feasibility Study for a proposed 12 turbine wind farm in the Moorfoot Hills (Galileo Empower UK Limited)
- Chapelcross Solar Farm, Annan, Dumfries and Galloway - Landscape and Visual Impact Assessment for a proposed 128 Hectare solar farm on an area of scrubland to the north west of the former Chapelcross Power Station site (Green Energy International)
- Cattybrook Solar Farm, Almondsbury, South Gloucestershire – Landscape and Visual Impact Assessment for a proposed 128 Hectare site to the north west of Bristol. Tasks included preparation of landscape strategy plan to identify appropriate landscape mitigation measures (Luminous Energy)
- Dell Wind Farm north of the Glendoe Hydro project, Highland - Ongoing Landscape and Visual Impact Assessment for a proposed 18 turbine wind farm, Section 36 application. Detailed design optimisation to eliminate effects on Castle Urquhart. Completion of challenging and remote site work. Coriolis
- Swarclett Wind Farm, Caithness - Landscape and Visual Impact Assessment for a proposed 2 turbine development. Wind2.
- Knockshinnoch Hydrogen Electrolyser, East Ayrshire – Preparation of a landscape and visual appraisal for a proposed hydrogen plant to capture renewable energy from an associated wind farm. The LVA included preparation of supporting visualisations. (Renantis)
- Drumduff Wind farm Extension, Blackridge West Lothian – Design optimisation followed by Landscape and Visual Impact Assessment for a proposed 3 turbine extension. GreenPower.
- Drumlithie Battery Storage Site, nr Stonehaven, Aberdeenshire – Preparation of a landscape and visual appraisal for a proposed 4 ha energy storage site.
- Kinmuck Battery Storage Site and Grid Station, nr Stonehaven, Aberdeenshire – Preparation of a landscape and visual appraisal for a proposed 4 ha energy storage site.
- Luggies Knowe Wind Farm, Mainland, Shetland - Preliminary design advice followed by ongoing Landscape and Visual Impact Assessment for a proposed c.2 turbine extension. Shetland Aerogenerators.
- Bettyhill Wind Farm Extension, Sutherland – Preliminary feasibility and design advice followed by ongoing Landscape and Visual Impact Assessment for a proposed c.11 turbine extension. Skelpick Estate
- Pencloe Wind Farm, New Cumnock, East Ayrshire – review of Landscape and Visual Impact Assessment for a tip height extension, Section 36c application.
- Yell Wind Farm, Yell, Shetland - Landscape and Visual Impact Assessment for a proposed 32 turbine, Section 36 application. Engagement with Shetland Island Council and SNH at an early stage to agree parameters and sensitivities associated with the proposal. Detailed design optimisation process to achieve a careful landscape fit. Statkraft / Energy Isles

- Jockstown Solar Farm, Dumfries and Galloway – Landscape and Visual impact Assessment for a proposed solar farm across mixed farmland near Annan. (Green Energy International).
- Caudwell Solar Farm, Cambridgeshire – Landscape and Visual impact Assessment for a proposed solar farm across a 113 Ha arable site near Holbeach. (Green Energy International).
- Bilbo and Frodo Solar Farms, nr Crimmond, Aberdeenshire – Landscape and Visual Impact Assessment for two proposed solar arrays extending to 44.5 Ha and 112 Ha respectively (Green Energy International)
- Patrickston Solar Farm, Kippen, Stirlingshire– Landscape and Visual Impact Assessment for a proposed 17.4 Ha solar array (Green Energy International)
- Greystone Knowe Wind Farm – Feasibility Study for a proposed 12 turbine wind farm in the Moorfoot Hills (Coriolis Energy Limited)
- Ulzieside Wind Farm, Dumfries and Galloway – Preparation of supplementary environmental information, including a comprehensive cumulative landscape impact assessment, to refresh an existing planning application following resolution of aviation constraints. NBW Wind Energy Ltd
- Turnalt Wind Farm, Argyll and Bute – Preliminary feasibility and design advice for a proposed wind farm site near Ardfern in mid Argyll. Coriolis Energy Limited
- Tidal Stream Array, Anglesey – site search for onshore cable land fall and sub station, for a proposed tidal stream array, to minimise landscape and visual effects. Anglesey Marine Energy, Morlais
- Blar Gavary Farm, near Bonar Bridge, Highlands – Baseline Landscape and Visual Impact Assessment for a proposed 10 turbine development. Eneco
- New Wind Farm Proposal, Powys – Preliminary feasibility and design advice for a non-TAN8 site in the Cambrian Mountains. Infinis
- Margree Wind Farm, Dumfries and Galloway – Preparation of supplementary environmental information to refresh an existing planning application following resolution of aviation constraints. NBW Wind Energy Ltd
- Starryshaw Wind Farm, Shotts, North Lanarkshire – Post application supplementary environmental information and consultation. Willowind
- Blairadam Wind Farm, Fife – Post application consultation. Partnership for Renewables
- Pencloe Wind Farm, New Cumnock, East Ayrshire - Landscape and Visual Impact Assessment for a proposed 19 turbine, Section 36 application. Engagement with East Ayrshire Council and SNH at an early stage to agree parameters and sensitivities associated with the proposal. Detailed design optimisation process to achieve a careful landscape fit. NBW Wind Energy Ltd
- Cummings Hill, nr. Jedburgh, Scottish Borders - Landscape and Visual Impact Assessment for a proposed 7 turbine development. Early stage submission of representations with regard to designation of Special Landscape Areas. Design optimisation process to balance production capacity and sensitive landscape receptors. Infinis
- Balunton Wind Farm near Bargrennan, Dumfries and Galloway - Ongoing Landscape and Visual Impact Assessment for a proposed 9 turbine application. The project became viable following a successful representation to the Dumfries and Galloway Interim Planning Policy for Renewables, arguing that the site was appropriate to be included as an unconstrained area of search. NBW Wind Energy Ltd.

- Kentish Flats Offshore Wind Farm Extension – Preparation of a landscape, seascape and visual impact assessment for 17 turbine extension to an existing offshore wind farm. Key tasks included seascape characterisation of the study area and advice on design optimisation. (Vattenfall)
- Blyth Offshore Demonstrator Project – Landscape Technical Lead for the now consented NaREC 15 turbine offshore test array. Key tasks include working within a 'Rochdale envelope' project description to identify the maximum scale of development with the least environmental harm and consultation with the MMO. (NaREC)
- Tullo Wind Farm Extension, Aberdeenshire - Landscape and Visual Impact Assessment for a proposed 5 turbine extension to an existing wind farm, near Stonehaven.
- Seagen Sea Skerries Tidal Stream Array, Anglesey – Technical review of Landscape and Visual Impact Assessment for the proposed turbine array. (MCT Ltd)
- Belmore Wind Farm – Settings assessment of Scheduled Ancient Monument sites prepared as an addendum to a EIA for a proposed wind farm in Northern Ireland. (Airtricity)
- Park Head Wind Farm – Landscape and Visual Impact Assessment for a proposed 9 turbine wind farm in Castle Morpeth District, Northumberland. (Renewable Energy Systems)
- Butterwell Wind Farm, Northumberland – Preparation of a detailed Landscape and Visual Impact Assessment for a 9no. turbine wind farm, including cumulative assessment of 7 adjacent sites. (Renewable Energy Systems)
- Tallentire Wind Farm, Cumbria –Baseline Landscape and Visual Impact Assessment for a 9no. turbine wind farm. (Renewable Energy Systems)
- Goonhilly Wind Farm – Landscape and Visual Impact Assessment for a proposed wind farm on the site of Goonhilly Downs Earth Station Site. (British Telecom/PMSS)
- Yelvertoft Wind Farm – Landscape and Visual Impact Assessment for a proposed wind farm close the M1 motorway in Northamptonshire. (Your Energy Ltd)
- Crockandun Wind Farm - Landscape and Visual Impact Assessment for a proposed wind farm on Slieve Gallion near Draperstown. (SWS Energy)
- Craignagapple Wind Farm - Landscape and Visual Impact Assessment for a proposed wind farm east of Strabane within the western extent of the Sperrin Mountains. (SWS Energy)
- Heysham Wind Turbine – Preparation of a Landscape and visual impact Assessment of a proposed large single wind turbine to the east of Heysham. (British Telecom)
- Tormywheel Wind Farm, Fauldhouse – Preparation of a comprehensive landscape strategy to provide mitigation to a proposed development of 14no. wind turbines. (PI Renewables)
- Perth and Kinross Wind Farm Policy – Preparation of representations to the Perth and Kinross Structure Plan on of behalf of the Scottish Renewables Forum as part of an objection to strategic wind farm planning policy in the region. (Scottish Renewables Forum)
- Slievekirk Wind Farm – Landscape and Visual Impact Assessment for an overhead pole mounted grid connection for a new wind farm in Northern Ireland. (Airtricity)
- Durran Mains – Feasibility and design work associated with a proposed borrow pit for a wind farm in Caithness. (DP Energy)
- Scottish Wind Farm Site Search – Support to RES in their prospecting for new Scottish Wind Farm sites. Advice focussed on a review of Landscape Character Types and their capacity for wind farm development. (RES)
- South and East of England Site Search – Services to RWE NPower in the preparation of sieve maping in GIS, followed by the identification and ranking of search areas. (RWE Npower)

- Numerous Planning Policy Representations on behalf of Wind Farm developers. (Wind Prospect, North British Wind Ltd, Infinis)
- Dunduff Quarry Wind Farm - Preparation of a landscape appraisal to inform the potential planning of a new small scale wind farm adjacent to an existing quarry development. (Patersons of Greenoakhill)
- Tesco CHP Plant Goole – Landscape and Visual Impact Assessment for a proposed Combined Heat and Power Plant at the Tesco distribution warehouse near Goole, East Riding of Yorkshire. (Tesco)
- Tesco CHP Plant Livingston – Landscape and Visual Impact Assessment for a proposed Combined Heat and Power Plant at the Tesco distribution warehouse in Livingston, West Lothian. (Tesco)

Environmental Impact Assessment

- Wavegarden, Ratho – Preparation of scoping correspondence with City of Edinburgh Council, including preliminary Zone of Theoretical Visibility plans to confirm that Landscape and Visual matters could be scoped out of the EIA process – (Tartan Leisure)
- Trengothal Radio Station, Land's End, Cornwall – Landscape and Visual Impact Assessment for a proposed large new satellite dish antenna at the Trengothal Radio Station site, including the preparation of indicative photomontages. The site is located in close proximity to sensitive Cornwall AONB. (BT/Avanti)
- Peffermill Sports Complex and Athletes Village – Landscape and Visual Impact Assessment for the proposed re-development of the Peffermill Sports Complex and associated Athletes Village, Peffermill, Edinburgh (Edinburgh University)
- Bangour Village – Landscape and Visual Impact Assessment for a residential development within the former Bangour Village Hospital site (Ambassador Group)
- Mixed Use Development Comprising Film & TV Studio Including Backlot Complex, Mixed Use Employment Uses, Straiton, Midlothian – Preparation of a comprehensive landscape and visual impact assessment for 36 Ha site to the south of Edinburgh. (Pentland Film Studios Ltd)
- Dolphingston, East Lothian – Preparation of a comprehensive landscape and visual impact assessment for a proposed new 8.72 Ha residential development to the south-west of Prestonpans. (Hallam Land)
- Orchardfield, East Linton, East Lothian – Preparation of a comprehensive landscape and visual impact assessment for a proposed new 6.32 Ha residential development, including indicative wireframe visualisations. (Stewart Milne Homes Ltd)
- Millerhill Zero Waste Facility. LVIA for a new large scale waste facility at Millerhill, Edinburgh. (Midlothian Council)
- Garreg Lwyd Hill Wind Farm, Wales - Preparation of a Landscape and Visual Impact Assessment and as part of an Environmental Impact Assessment for a new overhead power line connecting from the substation in the middle of the Proposal site at Tre-foel over a course of 39km south to just beyond Kington in Herefordshire. (RES)
- Robin House Children's Hospice, Balloch - Landscape and Visual Impact Assessment Children's Hospice Association Scotland's second children's hospice for Scotland, Robin House in Balloch near Loch Lomond, open to children with life-limiting / terminal conditions and their families. Significantly the LVIA was carried out in the context of the newly formed Loch Lomond and the Trossachs National Park. Despite the design having been commended by bodies such as The Royal Fine Arts Commission, the new Park Authority's Planning advisor recommended the project for refusal on site and policy issues. Permission was granted at committee following completion of the LVIA.

- Global Point International Business Park, Belfast – Preparation of a Landscape and Visual Impact Assessment and Concept Design Statement as part of an Environmental Impact Assessment for a new 200 acre Business Park. (Invest Northern Ireland/Pro Logis)
- Castlecourt, Belfast – Preparation of a Townscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a 500,000 ft² extension to city centre shopping mall. (Westfield Shopping)
- Dunadry, Nr. Antrim – Preparation of a Landscape and Visual Impact Assessment and Concept Design Statement as part of an Environmental Impact Assessment for a new garden village settlement. (Lagan Developments)
- Mullingar Business Park, County Westmeath, Eire – Preparation of a Landscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a new 70 acre business park. (IDA)
- Ballyoan, Londonderry – Preparation of a Landscape and Visual Impact Assessment and as part of an Environmental Impact Assessment for a 95 acre settlement expansion. (Various)
- 'K' Village, Kendal - Detailed townscape assessment forming part of an Environmental Impact Assessment for the redevelopment of a former shoe factory as a factory outlet centre. (Guinea Group)

Quarry Related Experience

- Willington Sand and Gravel Pit Extension, Trent Valley, Derbyshire – Landscape and Visual Impact Assessment and mitigation strategy for the proposed quarry extension. (Cemex)
- Swinton Quarter Craft Stone Quarry, Swinton, Scottish Borders – Landscape and Visual Impact Assessment and mitigation strategy for the proposed re-opening of a small stone quarry in the Scottish Borders. (Hutton Stone)
- Comrie Colliery Reclamation Scheme, Comrie Open Cast Site, Oakley, Fife – Restoration planting strategy for the re-formed earthworks associated with this former open cast coal mine.
- Borrow Pits, Burn of Whilk Wind Farm, Caithness – Quarry phasing design and mitigation strategy for the proposed re-opening of a small hard rock quarry.
- Tarfhaugh Sand Pit, West Linton, Scottish Borders – Preparation of draft quarry development proposals as part of feasibility study for the potential opening of a sand and gravel quarry on the site of a glacial kame feature near West Linton.
- Durran Mains – Feasibility and design work associated with a proposed borrow pit for a wind farm in Caithness. (DP Energy)
- East Garnock, Quarry Design and Restoration - Lead design and planning of a 120Ha quarry proposal for a site in North Ayrshire. The design proposals include progressive restoration of the 7 million tonne extraction phased over 20 years. Restoration is focussed on the creation of extensive areas of new wetland habitat and tidal lagoons. (NPL Estates)
- Levenseat Quarry Extension, Fauldhouse, West Lothian – Preparation of full and detailed Landscape and Visual Impact Assessment in support of an application for a 12Ha extension to an existing sand and gravel quarry. (WBB Minerals)
- Levenseat Quarry Re-Phasing – Preparation of a presentation to illustrate proposals for an application to vary a Planning Consent. The presentation prepared in Powerpoint included the design of the proposed quarry phasing over a 20 year period alongside an accompanying landscape mitigation strategy. (WBB Minerals)

- Edston Quarry, Peebles – Preparation of a Landscape and Visual Impact Assessment (LVIA) in support an application to re-open a small hard rock quarry. The assessment included proposals for mitigation and quarry phasing.
- Craigiehill Quarry, Edinburgh - Dormant hard rock quarry. Landscape and Visual Impact Assessment (LVIA) as part of an EIA and Restoration Strategy for a change of use from a quarry to a recycling facility. (Tarmac)
- Beltmoss Quarry, Kilsyth, North Lanarkshire - Hard rock quarry. LVIA as part of an EIA and Restoration Strategy for an extension to an existing quarry. Followed by Determination of Conditions Application in respect of Conditions appended to Planning Permission. (Patersons of Greenoakhill)
- Cruicks Quarry, Inverkeithing, Fife - Hard rock quarry making aggregates. LVIA followed by Determination of Conditions Application in respect of Conditions appended to Planning Permission. Contract Administration of initial phase of the restoration planting works. Subsequent preparation of detailed restoration proposals to support an application for quarry deepening. (Tarmac)
- Cotside Quarry, Carnoustie, Angus - Sand and gravel quarry. LVIA and Restoration Strategy as part of an Environmental Impact Assessment for an extension to the existing quarry. Followed by Determination of Conditions Application in respect of Conditions appended to subsequent Planning Permission.
- Cunmont Quarry, Dundee, Angus - Hard rock quarry LVIA as part of EIA and Restoration Strategy for an extension to an existing quarry. Followed by Determination of Conditions Application in respect of Conditions appended to Planning Permission. (Ennstone Thistle)
- Boyne Bay, Portsoy, Aberdeenshire - Limestone quarry. Preparation of a Restoration Strategy as part of an application to modernise working conditions and a Planning Application for a quarry extension. (Boyne Bay Lime Company)
- Lough Fea, Draperstown, County Antrim, Northern Ireland - Sand and gravel quarry LVIA as part of an EIA and Restoration Strategy for a new sand and gravel quarry. (FP McCann)
- Altnamuskin Quarry, County Tyrone, Northern Ireland - Sand and gravel quarry. Preparation of a Restoration Strategy as part of a Determination of Conditions Application to the Planning Permission. (Mullin and Sons)

Masterplanning

- Winning entry for the Moorside Earthworks Competition in the west of Cumbria. The earthworks will form the setting to Europe's largest nuclear new build power station site at Moorside, planned by NuGen. https://www.landscapeinstitute.org/news/five-shortlisted-for-moorside-landscape/
- Bangour Village Hospital, West Lothian – Preparation of the Landscape Masterplan for the conversion of the former hospital site in a housing led masterplan. Ambassador Group Ltd.
- Preparation of a Concept Master Plan of Belad Al-Husayneya, Mecca, Saudi Arabia – Preparation of a concept masterplan and early stage design principles for a new suburban extension to the Holy City of Mecca. The preliminary concept design was developed from initial masterplan baseline studies, through a series of design options, followed by the adoption a final concept masterplan. (Al Waqif Family/Khatib and Alami)
- Raith Estate, Kirkcaldy West - Preparation of Concept Masterplan and detailed supporting statement as part of representation to the FIFEPlan Local Development Plan. (Raith Estates)
- Ardeer Peninsula, North Ayrshire - Masterplan led regeneration strategy for a 100 Hectare site to deliver of a mix of suitable and sustainable end uses. A series of

Masterplan options have been prepared for the heavily constrained and contaminated site which are subject to an ongoing SEA process. Enviros have coordinated Stakeholder consultation and a series of public exhibitions which have led to the selection of a preferred Masterplan option.

- Tamfourhill, Falkirk – Preparation of a Concept Masterplan to guide Falkirk Council in planning the redevelopment of contaminated lands adjacent to the Union Canal. The proposals considered the integration of the Falkirk Wheel Visitor Centre, the Antonine Wall and the redevelopment proposals beside the canal including: residential; business; and commercial boat services/canal basins. (Falkirk Council)
- Former Woodilee Hospital, Lenzie - Masterplan led regeneration of a former hospital site for a new village development at Woodilee, Lenzie. The detailed site planning of the village was designed in accordance with the ‘home zones’ principle and included the formation of a market street as the core to the proposed development.
- Dunadry Garden Village, Nr. Antrim – Preparation of a Concept Master plan, as part of an Outline Planning Application, for an innovative garden village of potential regional significance. The new village proposals include a mixed use development of approx. 1500 houses arranged around a central core, including parkland, local services, community facilities and a small business park. (Lagan Developments)
- Global Point International Business Park – Preparation of a detailed Master plan, as part of an Outline Planning Application, in support of a new 200 acre business park on the edge of Belfast. The development proposals consist of 1.45millon ft2 of business floor space set within a high quality landscape that includes linear parks, formal recreational facilities, a ‘village centre,’ and structural woodlands. Following on from the master planning stage a design brief was developed to provide a coherent and practical framework for the future development of the business park. (Invest Northern Ireland/Pro Logis)
- Middlefield, Falkirk – Preparation of a Concept Master plan in support of a proposed mixed use Business Park at Middlefield, Falkirk. The masterplan was accompanied by a design guide for the long term sustainable development of the site. (Callendar Estate)
- Dundee Western Villages – Master planning for a new village development to the west of Dundee. The detailed site planning of the village was designed in accordance with the ‘home zones’ principle and included the formation of a market street as the core to the proposed development. The proposed development has received detailed planning consent. (Bett Homes)
- Collinswell Park, Burntisland – Master planning for the development of a new residential development on the site of a former Aluminium Works. The scheme is centred on a new public park which was carefully designed to accommodate flood waters from the Kirkton Burn. (Collinswell Land)
- Blair’s College Aberdeen - Preparation of Concept Masterplan for the re-development of a seminary college near Banchory. The proposals include a luxury hotel and signature golf course and golf related facilities, integrated with the development of 280 residential units. (Muir Group)
- Land at East Haddington – Preparation of a Concept Masterplan for a proposed settlement expansion and golf course extension to the existing Amisfield Golf Course on lands to the east of the village of Haddington in East Lothian. (Bryant Homes)
- Longniddry, East Lothian – Preparation of a Concept Masterplan for the expansion of an existing settlement incorporating a new golf course and country Club. (Bryant Homes)

Major Infrastructure Projects

- Jubilee River (Maidenhead, Windsor and Eton Flood Alleviation Scheme) - Design and implementation of 11.5km of new river channel to alleviate flooding along the River Thames, including Environmental Management throughout the contract period. (Environment Agency)

- M25 Widening - Comprehensive scheme design for proposed Motorway widening between Junctions 12-15 including comprehensive landscape and visual impact assessments and mitigation design. (Highways Agency)
- A1M Alconbury to Peterborough - Design and implementation of highway upgrade and widening including Environmental Management throughout the contract period. (Highways Agency)

Infrastructure Projects

- EE Mobile Phone Mast Roll Out – Preparation of landscape and environmental planning services to support the implementation of emergency mast sites throughout Scotland.
- Finnieston substation, Glasgow - Preparation of detailed landscape mitigation proposals for the city centre development (Scottish Power, 2011)
- Kentish Flats Offshore Wind Farm Extension - Preparation of a landscape, seascape and visual impact assessment for 17 turbine extension to an existing offshore wind farm. The work included the assessment of the cable landfall, transition pit and options for routeing of the underground cable corridor over a 2km route from Whitstable to the onshore grid station. Support given on this NSIP through EIP process (Vattenfall ,2011).
- Proposed Substation, Swansea North - LVIA for a proposed 400kV substation near at Swansea North. The scheme has successfully been granted planning permission (National Grid plc, 2010)
- Blyth Offshore Demonstration Project - Confirmation of preferred route corridor for connection of a 1.5km underground HVDC route for the 275 kV export cables from the cable landfall and transition pit to the Blyth substation (formerly Blyth Power Station) owned by National Grid. Included extensive consultation and negotiation with Natural England (NAREC, 2011)
- Slievekirk Wind Farm - Landscape and Visual Impact Assessment for an overhead pole mounted grid connection for a new wind farm in Northern Ireland. (Airtricity, 2010)
- Garreg Lwyd Hill Wind Farm, Wales - Preparation of a Landscape and Visual Impact Assessment and as part of an Environmental Impact Assessment for a new overhead power line connecting from the substation in the middle of the Proposal site at Tre-foel over a course of 39km south to just beyond Kington in Herefordshire. (RES, 2010)

Townscape Studies and Assessments

Experience with a range of urban assessment work for a variety of new retail, commercial and residential development, covering a wide range of townscape analysis and surveys for urban renewal, regeneration and design studies.

- One Cowcaddens – Preparation of a townscape and visual impact assessment for a mixed use development on the site of Buchanan House, Cowcaddens, Glasgow (Keppies Architects)
- Tileyard Road, Islington, London – Preparation of a townscape and visual impact assessment for a proposed laboratory building close to Kings Cross (Kadans/David Miller Architects)
- Brandon Road, Islington, London – Preparation of a townscape and visual impact assessment for a proposed laboratory building close to Kings Cross (Kadans/David Miller Architects)
- 21-41 – Queen Street - Preparation of a townscape and visual impact assessment for a proposed 14 storey student accommodation block, with a retained lower façade former 19th century warehouse within the Glasgow Central Conservation Area, Glasgow (Flow Design Architects).

- Merlin Place, Cambridge – Preparation of a townscape and visual impact assessment for a proposed laboratory building on 'landmark' site between the Cambridge Science Park and St John's Innovation Park (HOK Architects).
- Portcullis House – Preparation of a townscape and visual impact assessment for a proposed 32 storey residential tower block in Blythswood, Glasgow (Hawkins Brown Architects/ Watkin Jones)
- Iona Street – Preparation of verified visualisations to support a proposed residential development in Edinburgh (Manson Architects)
- Bonnington Road Lane – Preparation of verified visualisations to support a proposed residential development in Edinburgh (JM Architects)
- Jeffrey Street - Preparation of Townscape and Visual Impact Assessment and verified visualisations to support a proposed hotel extension development in Edinburgh (CFP Architects)
- Calton Hill, City Observatory Project – Townscape and Visual Impact Assessment for the proposed refurbishment and re-development of the City Observatory Compound. Key issues included consideration of the effects of a proposed new 'Salon' housing a restaurant, designed to reflect the adjacent neoclassical architecture, on the city skyline, the Edinburgh World Heritage Site and associated conservation designations.
- Royal Edinburgh Hospital (REH) Edinburgh - Townscape and Visual Assessment (TVA) for the proposed redevelopment of existing hospital complex in south Edinburgh suburbs to modernise and improve facilities, while retaining the key parkland edges and other important townscape/ landscape features and minimising effects on patients and surrounding residents. Hub South-east Scotland
- Port of Leith Redevelopment - Responsible for townscape and visual impact assessment and advice and guidance on the overall project design optimisation for the proposed redevelopment and extension of the Port of Leith, Edinburgh. Within this complex environment close to conservation areas, listed buildings and extensive areas of residential development key services included negotiation on the scope of the assessment with Statutory Consultees. 2012 – Ongoing. Scottish Enterprise / Forth Ports
- Audley Square, Mayfair – Preparation of a Townscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a new hotel and apartment complex within the heart of Mayfair. The proposals for the eight-storey building were developed with Foster and Partners. Architects. (Hedleigh (Mayfair) Ltd)
- Royal Shakespeare Theatre, Stratford Upon Avon – Detailed Townscape and Visual Impact Assessment forming part of an Environmental Impact Assessment for the redevelopment of the existing Royal Shakespeare Theatre. (Royal Shakespeare Company Ltd)
- Woodside Quarry, Horsforth, Leeds – Preparation of a Townscape and Visual Impact Assessment as part of an Environmental Impact Assessment for a mixed-use development within the context of a former sandstone quarry within suburban Leeds. The proposals include a mix of residential and commercial uses including a small community hub centred around a high-quality public realm. (Burford Group Ltd)
- Gallowgate, Newcastle Upon Tyne - Preparation of a Townscape and Visual Impact Assessment, including a night time lighting impact assessment as part of an Environmental Impact Assessment for a mixed-use development on the former Tyne Brewery site. The proposals included: a hotel; offices; student halls of residence; and a residential accommodation, located within five separate buildings. (Storeys SSP/Downing)
- St. Andrews Greenbelt Study.
- South East Wedge, Edinburgh, Green Belt Study.

- Donaghadee – Preparation of a Town Strategy presenting an overview of the area's key characteristics, needs, issues and priorities, including a literature review, local survey/public consultation and report. (Ards Borough Council)
- Glengormley and Ballyclare – Town centre re-generation studies. (Newtownabbey Borough Council)
- Lee Valley Regeneration Study – Preparation of a regeneration strategy and associated environmental enhancements for the River Lee. (London Borough of Hackney)

Landscape Design and Implementation

- Nationwide House, Croft Campus, Swindon – Lead design consultant for major projects at Nationwide Building Society's Headquarters in Swindon, associated with the development of the Headquarters Campus for the Nationwide Building Society. These have included: the design and implementation of a new Decked Car Park and associated roof garden; major campus wide environmental enhancements; and, the construction of a new system of site access and circulation. All projects have included liaison with an extended project team, detailed contract management and inspection within the context of an extremely busy campus environment used by 3000 employees. (Nationwide Building Society)
- West Mill Road, Colinton, Edinburgh – Preparation of detailed hard and soft landscape proposals for a new residential development to discharge Planning Conditions, followed by the implementation of the scheme on site. (Applecross Properties Ltd)
- New Baptist Church, Moira, Northern Ireland – Preparation of detailed hard and soft landscape proposals for a new church to discharge Planning Conditions, followed by the implementation of the scheme on site.
- Eastfieldburn, Cambuslang – Preparation of detailed hard and soft landscape proposals for the restoration of a disused mine. Specifically, the proposals included the formulation of strategy to eradicate a Japanese knotweed infestation.
- 23a Northumberland St, Edinburgh – Preparation of detailed hard and soft landscape proposals associated with a domestic extension and new garden, followed by the implementation of the scheme on site.
- Cruicks Quarry, Inverkeithing – Preparation of detailed quarry restoration planting proposals to discharge Planning Conditions followed by on site implementation, contract management and inspection and ongoing maintenance.
- Altonhill, Kilmarnock – Preparation of detailed soft landscape proposals associated with a new residential development, initially to discharge Planning Conditions, followed by on site implementation, contract management and inspection and ongoing maintenance.
- Swanley Town Centre - Detailed design and implementation of town centre environmental enhancements. (Swanley Borough Council)
- Kuwait Oil Sector Complex - Preparation of detailed proposals for the design of a new flag ship development in Kuwait City. (Kuwaiti Ministry of Oil)

Urban Design

- Bells Mills, Dean Village, Edinburgh – Site planning and preparation of hard and soft landscape proposals as part of a Planning Application for 24no. apartments within 4no. 3-4 storey blocks for a vacant overgrown site adjacent to the Water of Leith. The scheme was successfully taken to appeal following a deemed refusal and is currently being worked up in detail for implementation. (Bishop Loch/BUREDI)
- Belford Lodge, Dean Village, Edinburgh – Similar scale and form of flatted apartment development for a nearby site beside the Water of Leith. The approved scheme is now also being worked up in detail for implementation. (Gregor Properties)

- Donaghadee – Preparation of a Town Strategy presenting an overview of the area's key characteristics, needs, issues and priorities, including a literature review, local survey/public consultation and report. (Ards Borough Council)
- Royal Quay, Harefield – Detailed planning application for a new residential development within the context of a Conservation Area, including hard and soft landscape proposals. (Ravenblack Developments)
- Gravesend – Detailed planning application for a new flatted apartment development overlooking the River Thames in Kent. The waterfront scheme includes the formation of a new riverside walkway focussed on a redeveloped pier and restaurant. (Ravenblack Developments)
- Ards Shopping Centre, Newtownards – Detailed hard and soft landscape design for the proposed re-development of a shopping centre. The extended development includes the creation of significant areas of formal and informal public open space, new squares, plazas and a water garden. A proposal for an extended earthwork feature forms the gateway to the development itself, Newtownards and the county of Ards and North Down. (Private Client)

Historic Garden Restoration Design

- Houghton Park - Preparation of detailed Restoration Management Plan for a Grade 1 registered park funded by English Heritage to improve the legibility of the landscape for visitors, re-create lost parkland and restore key relationships between the park and surrounding buildings. (Lord Cholmondeley)
- Regency Parks Brighton - Preparation of detailed proposals for the restoration of the existing dilapidated parks within Brighton. (Brighton and Hove Borough Council)
- Norfolk Square, Brighton - Site planning through to on site implementation for the restoration of Norfolk Square, Brighton. (Brighton and Hove Council)

Other Interests

- World travel, walking and mountaineering, climbing, ski-touring, cycling, vegetable growing, cooking, river and sea-kayaking, art.

Appendix 2.1 Sub-orbital – Orbital Launch Comparison

Orbex PRIME Launch Vehicle

The Orbex PRIME Launch Vehicle is used for both sub-orbital and orbital launches.

The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two-stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure and designed to launch payloads of up to 180 kg into both sub-orbital and orbital trajectories.

The Orbex PRIME Launch Vehicle composition includes carbon fibre reinforced plastic (CFRP), aluminium alloys, inconel alloys, stainless steel alloys, niobium alloys, copper alloys, ceramics, polymers/plastics, and batteries in varying quantities. The second stage incorporates small quantities of gaseous helium for use in the reaction control system. No pyrotechnics form any part of the Orbex PRIME Launch Vehicle. The fuel for both the first and second stages is LPG with LOX as the oxidiser. Helium is utilised on both stages for pressuring the fuel and oxidiser tanks.

Orbex PRIME – Orbital Launches

Orbital launches will take place along flight corridors with azimuths of 085 - 100 degrees from the equator, and will only be allowed to occur when meteorological conditions are such that no southerly movement of the Orbex PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences.

A typical orbital flight will involve the Orbex PRIME Launch Vehicle taking off vertically from SaxaVord Spaceport and flying directly upwards for a short period before pitching over to a horizontal orientation and accelerating towards orbital velocity. The first stage ascent operates for approximately 167 seconds before engine cut off. Following engine cut off, the first stage is released prior to the second stage engine start sequence. Following separation, the first stage and interstage will return to Earth in a pre-designated drop zone typically 8 - 10 minutes after launch.

Following stage separation, the second stage will ignite and carry the vehicle to orbit, with the payload bay fairings being dropped as the second stage reaches space. This initial burn lasts approximately five minutes, and it delivers the vehicle to the required elliptic orbit. Another second stage engine ignition will occur to circularise the final orbit, at which point, the payload(s) will be deployed.

After separating the payload(s), the second stage will complete an additional re-entry burn and re-enter the Earth's atmosphere, leaving no debris in space.

The impact zones for the first stage, interstage and fairings are expected to occur in marine locations between Scotland and Greenland, as shown on Figure 1.

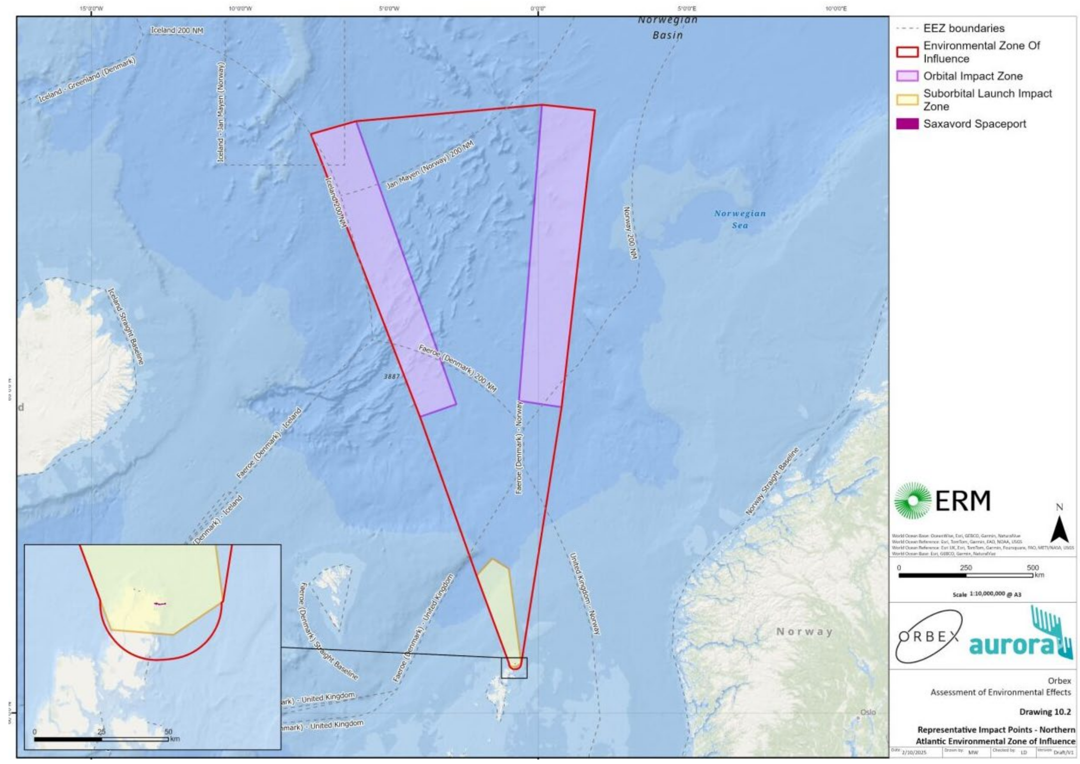

Figure 1 Orbital Launch North Atlantic Drop Zones and Sub-orbital Drop Zone

The impact zone for the deorbiting second (orbital) stage is anticipated to occur in the South Pacific as shown on Figure 2.

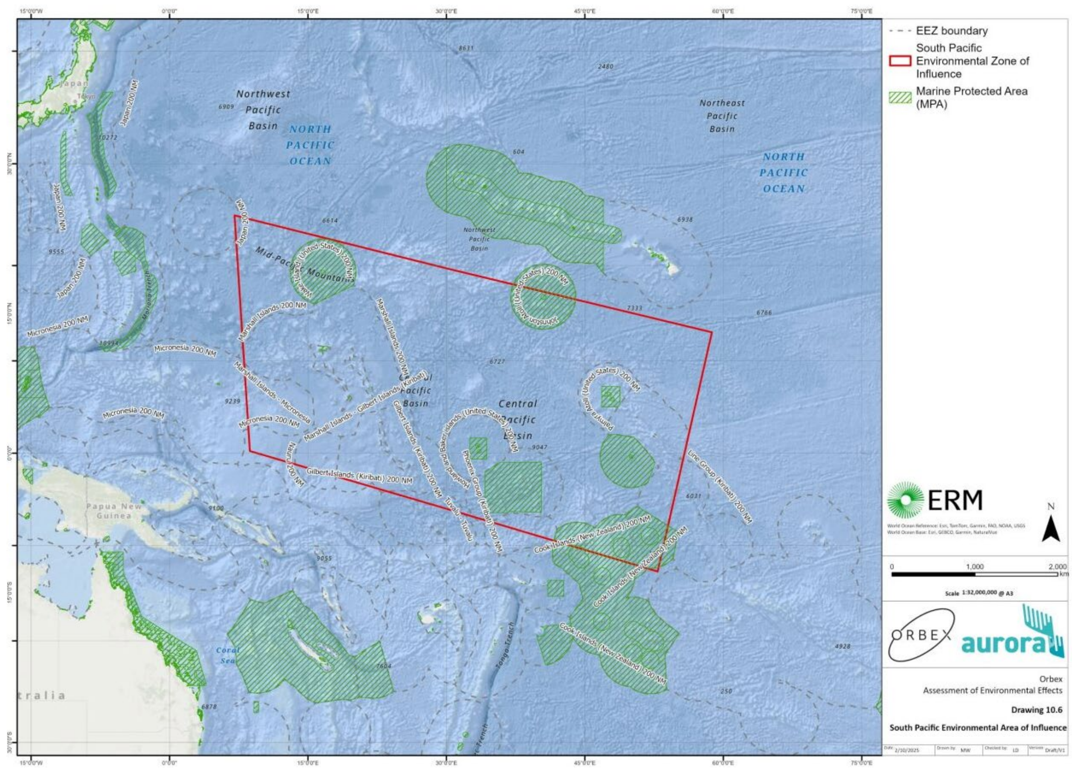

Figure 2 Orbital Launch Second Stage Drop Zone

Orbex PRIME – Sub-orbital Launches

Sub-orbital launches will take place along a northerly azimuth (089.50 degrees from the equator) from the launch site and will only be allowed to occur when meteorological conditions are such that no southerly movement of the Orbex PRIME Launch Vehicle is possible, considering both nominal and off-nominal launch event sequences.

A typical sub-orbital flight will involve the Orbex PRIME Launch Vehicle taking off vertically from SaxaVord Spaceport and flying upwards for a short period before pitching over to a horizontal orientation and accelerating towards a maximum altitude of 400 km. The first stage engines will operate for approximately 165 seconds before engine cut off. Following engine cut off, the Orbex PRIME Launch Vehicle will return to Earth as one component in a pre-designated drop zone.

The trajectories, distance to and scale of drop zone for returning material from sub-orbital launches is spatially limited compared to orbital launches, as sub-orbital launches have a reduced range. The ground-track distance between the launch site and the returning component drop zone (Launch Vehicle remains intact) for sub-orbital launches is anticipated to be approximately 155km. The area of impact for sub-orbital launches is encompassed within the area considered for orbital launches, as shown on Figure 1.

AEE Precautionary Approach

This AEE therefore considers the potential effects of orbital launches of the Orbex PRIME Launch Vehicle as the worst-case scenario, as these are predicted to have greater effects across all impact pathways.

Appendix 2.2 Justification for no further assessment of Landscape, Seascape and Visual Impact

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Ruth Fain
Aurora Limited
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17th February 2025

PD – Ruth Fain – 17.02.2025
ALP2025/02

Dear Ruth,

Orbital Express Launch Limited, Unst, Shetland –Landscape, Seascape and Visual Effects

Thank you for your recent correspondence with regard to the preparation of a Landscape and Visual Impact Assessment to form part of the Assessment of Environmental Effects (AEE) for the Proposed Project set out by Orbital Express Launch Limited and comprising forthcoming Orbex PRIME launch operations at SaxaVord Spaceport in Unst, Shetland.

Proposed Project

The Proposed Project comprises the preparation and launch of Orbex PRIME Launch Vehicles onto both sub-orbital and orbital trajectories, from Launch Pad 3 at SaxaVord Spaceport Lamba Ness Launch Site (LNLS) situated on the Lamba Ness peninsula in Unst, Shetland. The Applicant is applying for a maximum environmental budget of 10 launches per year which will make up one third of SaxaVord Spaceport's own assessed environmental budget of 30 launches per year.

The Proposed Project will utilise the following existing SaxaVord Spaceport infrastructure at the LNLS:

- Launch Pad 3: the most easterly of the three launch pads located on the Lamba Ness peninsula; Launch Pad 3 incorporates ground services storage and control, lightning protection masts, liquid and compressed gas storage and water deluge tanks for launch operations;
- Satellite Tracking Station: an area of hardstanding housing satellite tracking and telemetry devices located on the Lamba Ness peninsula;
- Integration Hangars – Rocket Hall 2 of the Integration Hangar A: located on the Lamba Ness peninsula, the building where the Orbex PRIME Launch Vehicles will be assembled and the payload(s) integrated;
- Administration Building and Hazardous Materials Store located on the LNLS;

- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings.

Proposed Launch Vehicle

The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m in diameter. It is a two stage liquid fuelled launch vehicle primarily comprised of a carbon fibre structure. The Orbex PRIME Launch Vehicle is designed to launch payloads of up to 180 kg into both suborbital trajectories and sun synchronous and polar orbits. All launches will take place in a northerly direction over the sea from Launch Pad 3 at SaxaVord Spaceport.

Potential Environmental Effects

The significant effects associated with operational launch activities referred to in the SR-APP-001019 document (including those of the Orbex PRIME Launch Vehicle), in summary, include the following elements:

- Preparation of the Orbex PRIME Launch Vehicle;
- Storage and handling of Orbex PRIME Launch Vehicle propellant;
- Operation of Ground Segment and Launch Complex; and
- Launch of Orbex PRIME Launch Vehicle (including discarded component drop zones).

The operational launch activities which encompass the Proposed Project will give rise to short term landscape and visual effects which have been reported within relevant assessments and documents submitted to Shetland Islands Council as part of the planning application for the SaxaVord Spaceport (reference 2021/005/PPF) and the SaxaVord Spaceport assessment of environmental effects (AEE) submitted to the Civil Aviation Authority (CAA) in 2022 (licence application reference SR-APP-001019) and are summarised below for information.

During the run up to and the launch of the Orbex PRIME Launch Vehicle, there will be a range of additional landscape effects experienced during the days preceding a launch and the ‘take off’ sequence itself. Given the very short term and temporal nature of these effects they are described briefly in the submitted SaxaVord Spaceport AEE as per the boxed text below, and have been adjusted to refer to the Orbex PRIME Launch Vehicle.

Typical Characteristics of a Launch

Prior to the launch, temporary vehicles, equipment and containers will be moved into position within the earth sheltered areas of hard standing, beside the launch pad. As the Orbex PRIME Launch Vehicle is prepared for launch it will be taken from the Integration Hangar to the launch pad and erected to a vertical position, held in place with a ‘strongback’, a metal structure that supports the launch vehicle during launch. In the same period the lighting masts will be extended to their maximum length.

Close to the launch, as propellants and fuels are loaded, there will be additional effects arising through the emission of occasional vapours, as well as the presence of activity and lighting. The Orbex PRIME Launch Vehicle may be at the launch pad for several days prior to launch and may be brightly illuminated at night during this time.

The launch of the Orbex PRIME Launch Vehicle will be very short in duration and give rise to a range of very short term but significant and widespread landscape and visual effects. As the ignition sequence commences, a process of water inundation is commenced as a measure to both reduce the roar of the launch but also to protect the Orbex PRIME Launch Vehicle from its own flames. The resulting interaction of the flames and water will give rise to a localised plume of water vapour and smoke at the base of the launch pad. This will quickly dissipate after take-off and is expected to flow away to the north-east given the predominant wind direction.

The launch itself will be very quick, with the Orbex PRIME Launch Vehicle moving above the strongback within approximately three seconds of initial firing, the overall noise and emissions reaching a peak up to 10 seconds into the launch, immediately reducing thereafter. The Orbex PRIME Launch Vehicle will be seen to speed away from the launch site, reaching an altitude of 1 km after approximately 28 seconds into the launch, and 2 km after approximately 38 seconds. There may at times be a visible trail or plume, however, it is expected that the principal feature of the lift -off will be the rapidly ascending cone of super-heated exhaust gases, immediately beneath the Orbex PRIME Launch Vehicle.

The short-term effects of the actual launch will give rise to significant very short-term effects on landscape and visual receptors with primary visibility extending across northern areas of Unst, largely coincident with the landscape and visual receptors reviewed in the assessment of operational effects of the SaxaVord Spaceport AEE. However, it is acknowledged that the Orbex PRIME Launch Vehicle itself will be visible for much greater distances for a very short period of time as it rises through the lower atmosphere. The trajectory of the launch will arc away from the Shetland Islands to the north across the North Sea and therefore direct visibility will rapidly decay.

These significant effects will give rise to short term changes in qualities of tranquillity experienced within the EZI, giving rise to very short-term disturbance. As such, whilst the effects of an individual launch will be short lived, it is noted that there will be an ongoing requirement to inform and consult with the public on issues arising from launches.

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Following any launch, the strongback will be lowered, the lightning masts retracted, and the temporary vehicles and containers removed from Launch Pad 3. The launch pad will return to its normal configuration within a few days.

Assessment of Environmental Effects

As the specification of the Orbex PRIME Launch Vehicle is within the envelope assessed for SaxaVord Spaceport (i.e., launches of sub-orbital sounding rockets and small satellites into either polar or sun-synchronous, low-earth orbits by multiple launch service providers (LSPs) using a range of different Launch Vehicle types up to 30 m in height), and there are no long-term significant effects arising from the Proposed Project that would be additional to the previously assessed operational effects of SaxaVord Spaceport, it is considered that no further assessment is required on top of that previously submitted in the SaxaVord Spaceport AEE.

The SaxaVord Spaceport AEE concluded that a number of very short term significant effects are predicted during any given launch event, including significant landscape effects on the landscape character of the site and its immediate surroundings, and significant visual effects on residents at local settlements and tourists, including recreational walkers, visiting the local area. However, it was also noted that effects during launch cycles arise from *"lightning masts, hardbacks and Launch Vehicles, erected at separate times on each of the launch pads, [which] will be seen as prominent structures"*. Of these elements, lightning masts and permanent hardbacks comprise Spaceport infrastructure and so it is noted that the effects of launches of the Orbex PRIME Launch Vehicle itself will be less than the combined predicted effects of all three elements.

The SaxaVord Spaceport AEE LVIA concludes that there are no permanent significant effects arising from individual launch events, only very short term effects. All permanent effects considered within the AEE are a result of Spaceport Infrastructure.

As included in Chapter 16 (paragraph 16.3.3) of the SaxaVord Spaceport AEE, "*The likely significant... landscape effects are inherently associated with the land-take and infrastructure required for the construction of the [SaxaVord Spaceport] and carry over into AEE only by nature of the continued operation of that development and infrastructure. [Landscape] aspects…have been assessed by Shetland Islands Council and the relevant statutory consultees (including HES, NatureScot and SEPA) during the planning application stage of the [SaxaVord Spaceport] and… found to be suitable… and included in the planning permission as conditions accepted as being appropriate from a planning perspective."*

As all significant residual effects (and potential alternatives) from launch events arising from operation of SaxaVord Spaceport were assessed by Shetland Islands Council and the relevant statutory consultees during the planning application stage, it is considered that the significant effects hepla

identified have been appropriately dealt with through the planning process and subsequent planning conditions and need not be considered further within the AEE regime. This was the finding of the SaxaVord Spaceport Operator AEE, and remains the case the for the Orbital Express Launch Limited Operator AEE in respect of the Orbex PRIME Launch Vehicle.

I trust this clarification of assistance.

Kind regards

Peter Dunmow CMLI

Director
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peter.dunmow@hepla.co.uk

Appendix 2.3 SaxaVord Spaceport AEE Landscape, Seascape and Visual Impact Chapter

CHAPTER 13 LANDSCAPE, SEASCAPE AND VISUAL IMPACT

Landscape, Seascape and Visual Impact

13. Landscape, Seascape and Visual Impact

13.1 Introduction

13.1.1 This chapter provides an assessment of the effects on landscape resources and visual amenity that are likely to result from the operation and maintenance of the Proposed Project.

13.1.2 The LVIA (Landscape and Visual Impact Assessment) chapter has been prepared by a Chartered Landscape Architect at Hermitage Environmental Planning and Landscape Architecture Limited (Hepla) with over 20 years of professional experience.

13.1.3 This chapter describes: the baseline landscape and visual conditions currently existing within the Proposed Project site and the surrounding LVIA Study Area which lies within the Environmental Zone of Influence (LVIA Study Area); the likely significant effects on the landscape and visual resource; the mitigation measures included to avoid, prevent, reduce or offset adverse effects; and the likely residual effects after these measures have been employed. The assessment is based on a potential reasonable 'worst case' scenario and the parameters that have defined this are set out in the methodology.

13.1.4 The LVIA concentrates on the key landscape and visual issues identified during the Environmental Impact Assessment (EIA) scoping stage undertaken as part of the planning application process. Consultation was undertaken with Shetland Islands Council and Scottish Natural Heritage (SNH, now NatureScot) in relation to:

- landscape effects – both physical changes to constituent elements of the landscape fabric, and how changes in the character and qualities of the landscape and designated areas are perceived by people, as a result of the Proposed Project; and
- visual effects – changes to views or visual amenity, as experienced by people, from key viewpoints, the surrounding sea, settlements, roads, footpaths and cycle routes, as a result of the Proposed Project.

13.1.5 Due to the proximity of the Proposed Project to the coastal edges of the northern islands of Shetland, the LVIA also considers effects on the coastlines and seascape. References to landscape effects used in this chapter also refer to effects on the coastlines and seascape.

13.1.6 The location of the Proposed Project and the extent of the Proposed Project boundary is shown on Drawing 13.1.1. This is also detailed in Chapter 3 (Proposed Project).

LVIA Contents

13.1.7 The LVIA is organised into the following main sections, with additional written data also included in appendices, as described below:

- Introduction;
- Project Description;
    - a description of the aspects of the Proposed Project with the potential to influence landscape and visual amenity within the LVIA Study Area;
- Design Optimisation and Mitigation Measures;
    - a description of how the layout and design has responded to potential landscape and visual effects over the duration of the Assessment of Environmental Effects process, and reference to the embedded mitigation measures incorporated at the design stage, aimed at avoiding, reducing or minimising potentially adverse landscape and visual effects;

- Policy;
    - a review of the policy context relevant to landscape and visual matters;
- Consultation;
    - a summary of the consultation completed to agree the scope of the assessment and how matters raised during the consultation process have been addressed;
- Methodology;
    - an explanation of how the LVIA has been carried out, with reference to recommended methodologies and guidelines;
- Existing Environment;
    - a description of the existing landscape and visual amenity and receptors identified within the application area and the wider LVIA Study Area;
- Assessment of Landscape and Visual Effects;
    - a detailed assessment of the likely significant effects arising from the operation of the Proposed Project on the landscape resources and the perception of landscape character and designated areas within the LVIA Study Area;
    - an assessment of likely significant effects on visual amenity arising from the operation of the Proposed Project, including an assessment from a range of viewpoints identified and agreed through consultation with Shetland Islands Council and SNH;
- A Summary of In-combination Landscape and Visual Effects;
    - an assessment of the effects arising from the operation of the separate elements of the Proposed Project in combination. Note that this is incorporated into the main assessment under consideration of each receptor rather than being presented separately;
- Summary
    - a summary of the key landscape effects (including seascape and coastal) and visual effects arising from the Proposed Project, and conclusions on the significance of effects.

Supporting Graphics

13.1.8 The LVIA chapter should be read alongside the following plans, photographs and visualisations, which are included in Volume III.

13.1.9 The baseline landscape and visual context is illustrated in: Drawing 13.1.1, LVIA Study Area/EZI; Drawing 13.1.2, Landscape Designations; and Drawing 13.1.3, Landscape/Coastal/Seascape Character Areas. Viewpoint locations are shown in Drawing 13.1.4.

13.1.10 The assessment of landscape and visual effects is supported by the Zone of Theoretical Visibility (ZTV) maps in Drawings 13.2.1 to 13.2.2, and viewpoint photographs and photomontages in Drawings 13.3.1.1 – 13.3.1.10, and 13.3.2.1 – 13.3.2.5.

Appendices

13.1.11 This chapter is accompanied by Appendices 13.1 to 13.6 in Volume IV. These provide greater detail and background information on:

- Appendix 13.1, LVIA Methodology;
- Appendix 13.2, Landscape Character Areas within the 15 km LVIA Study Area;
- Appendix 13.3, Coastal Character Areas within the 15 km LVIA Study Area;

- Appendix 13.4, Seascape Character Areas within the 15 km LVIA Study Area; and,
- Appendix 13.5, Special Qualities Assessment, Shetland National Scenic Area.

Project Description

13.1.12 The assessment covers the operational of the Proposed Project, as described in Chapter 3.

13.1.13 The infrastructure required for the Proposed Project consists of:

- Launch Site: located on the Lamba Ness peninsula and comprising three launch pad complexes, each incorporating a launch pad, ground services storage and control, lightning protection masts, liquid and compressed gas storage and water deluge tanks for launch operations;
- Antenna Area: up to four areas on the Lamba Ness peninsula for telemetry, flight termination systems and satellite tracking;
- Integration Hangars (three): located on the Lamba Ness peninsula, a building where the launch vehicles are assembled, and the payload (the satellites) prepared and integrated into the launch vehicles;
- Administration Building, Pyrotechnics Store, and Hazardous Materials Store;
- Support Infrastructure: located on the Lamba Ness peninsula including access, an internal track system and a series of small temporary buildings;
- Gate House, including a tourist information area, located on the Lamba Ness peninsula; and
- Wildlife Hide: located on the Lamba Ness peninsula.

Design Optimisation

13.1.14 Consideration of landscape and visual effects of operation of the Proposed Project has been considered as part of the evolution of project design via LVIA at the planning stage and as such mitigation of the effects of the Proposed Project have been embedded into the design. As such, all the effects from the operational stage described herein are essentially residual effects.

13.2 Legislation, Policy and Guidance

13.2.1 The legislation, policies and guidance relevant to the LVIA are set out below, and Drawing 13.1.2, Volume III identifies the location and extent of the landscape policy designations.

Legislation

Space Industry Act

13.2.2 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK’s territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

Policy

13.2.3 Whilst there is no policy specific to the assessment of the landscape and visual effects of space ports, given the Proposed Project's characteristics, it is possible to follow existing guidance with regard to the effects of development from the planning regime.

National Policy

Scottish Planning Policy

13.2.4 Scottish Planning Policy (SPP) is the statement of the Scottish Government's policy on nationally important land-use planning matters. The 2014 document provides the core principles, statutory guidance, planning policies, and expectations of the Scottish planning system.

13.2.5 SPP acknowledges the importance of protecting valuable landscapes at an international, national and local level to ensure that *"the character and quality of a landscape which is important or particularly valued locally or regionally"* is safeguarded or enhanced. (Para 199)

13.2.6 SPP goes on to state that *"the siting and design of development should take account of local landscape character"* and notes that *"developers should seek to minimise adverse impacts through careful planning and design, considering the services that the natural environment is providing and maximising the potential for enhancement."* (Para 202)

13.2.7 Development of the land will aim to retain and enhance the positive aspects of the site's natural features, whilst addressing potential impacts on both the environment of the adjoining residential areas and the wider setting by promoting a proactive mitigation strategy.

Regional Policy

The Shetland Local Development Plan, 2014

Policy GP3, All Development: Layout and Design

13.2.8 Policy GP3 states that: *"All new development should be sited and designed to respect the character and local distinctiveness of the site and its surroundings,"* and goes on to set out that *"development should make a positive contribution to"* a number of considerations, including, *"maintaining identity and character."*

Policy NH1, International and National Designations

13.2.9 Policy NH1 states that: *"Development that affects a National Scenic Area…will only be permitted where:*

- It will not adversely affect the integrity of the area or the qualities or protected features for which it has been designated, or
- Any such adverse effects are clearly outweighed by social, environmental or economic benefits of national importance."

Policy NH4, Local Designations

13.2.10 Policy NH4 states that: *"Development that affects a Local Nature Conservation Site or Local Landscape Area will only be permitted where:*

- It will not adversely affect the integrity of the area or the qualities for which it has been identified; or
- Any such effects are clearly outweighed by social, environmental or economic benefits."

Policy HE5, Gardens and Designed Landscapes

13.2.11 Policy HE5 states that: *"Development affecting gardens and designed landscapes should protect, preserve and enhance such places and should not impact adversely upon their character, upon important views to, from and within them, or upon the site or setting of component features that contribute to their value."*

Guidance

Guidance for the Assessment of Environmental Effects

13.2.12 The Department for Transport document "Guidance for the Assessment of Environmental Effects" explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act and sets out the environmental topics likely to be affected by the proposed activities.

13.2.13 The Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including landscape and visual impact, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- The AEE should explain what other environmental assessments have been conducted in relation to the proposed activities (e.g., EIAs provided as part of a planning application) and whether they are being used in support of the AEE;
- Applicants for a spaceport licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including landscape and visual impacts.

13.3 Consultation

Scoping

13.3.1 Extensive statutory consultation on LVIA was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Information provided to consultees included a draft zone of theoretical visibility (ZTV) and a list of suggested viewpoints with grid coordinates, which it was proposed would be assessed within the LVIA for EIA

13.3.2 Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 13.1.

Table 13.1 Consultation Relevant to AEE

Consultee	Comment
Shetland Islands Council - Natural Heritage Officer Comments, 1st July 2020	Rather than Assessing the Impacts on Wild Land: Interim Guidance Note, SNH Heritage (2007), please use the current advice, which is Assessing impacts on Wild Land Areas -Technical Guidance note Consultation - SNH Jan 2017

Consultee	Comment
	The standard reference that describes landscape character in Shetland is now the "Scottish Landscape Character Types Map and Descriptions" (SNH, 2019) - https://www.nature.scot/professional-advice/landscape/landscape-character-assessment/scottish-landscape-character-types-map-and-descriptions, rather than the 1998 Gillespies report referred to. I'm pleased to see that the LVIA will include coastal character assessment, but I suggest you also assess to include the character of 20. Skaw Coastal Character Area, as well as area 16. East Unst Coastal Character Area I am of the view that the LVIA should also include an assessment of the [Proposed Project's] landscape and visual impact as viewed from the sea; namely, its impact in relation to its seascape character type (as described in "An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms. Scottish Natural Heritage Commissioned Report No.103, Scott, K.E., Anderson, C., Dunsford, H., Benson, J.F. and MacFarlane, R. (2005)). The [Proposed Project] site is remote, isolated and essentially undeveloped with extensive visibility from the sea. That report describes 2 seascape character types for Shetland, namely: Type 1: Remote High Cliffs Type 13: Low, rocky island coasts The area for the Proposed Project is described as Low, rocky island coasts. I should be happy to discuss how that might be achieved. In terms of the Key Questions for Consultees ➢ I confirm that GLVIA3 is the correct framework for the methodology ➢ I am content with the proposed 15 km extent of the LVIA Study Area; ➢ I am content with the proposed viewpoint selection, which are sufficiently representative ➢ The only other documents I suggest you refer to are noted above ➢ I am not aware of any other development proposals that should be considered in the cumulative assessment ➢ I am content with the important landscape and visual receptors selected.
Scottish Natural Heritage (now NatureScot), Jonathan Swale, 7th July 2020	We are content with the scope of your proposed LVIA.

13.4 Assessment Methodology and Significance Criteria

13.4.1 This chapter is supported by Appendix 13.1, which contains a detailed description of the method of assessment.

Guidance

13.4.2 The Landscape and Visual Assessment methodology follows good-practice guidance and advice on the assessment of the impacts of development on landscape and visual resources. A key source of guidance is the Guidelines for Landscape and Visual Impact Assessment (Third Edition, 2013) (GLVIA 3). Other documents specific to photography and visualisation techniques, and cumulative impacts have also been referred to. These are listed in full in Appendix 13.1 Volume IV.

Overview of Methodology and Limitations

13.4.3 The general approach to the LVIA includes the following key tasks:

- Desk study: A desk study was undertaken to define the baseline landscape and visual resource within the LVIA Study Area and identify the main users of the area, key viewpoints and key features. Refer to Appendix 13.1 for further details;
- Field survey: The landscape and visual resource identified through the Desk Study was then verified through field survey work. This allowed the assessor to gain a full appreciation of the relationship between the Proposed Project and the landscape. Refer to Appendix 13.1 for further details;
- Confirmation of scope, methodology and confirmation of the viewpoints to be included in the assessment was completed through correspondence with Shetland Islands Council and NatureScot. Viewpoints are used as a proxy in order to understand effects across the LVIA Study Area, because it is not feasible to make an assessment of every visual receptor across an extensive area. This is standard practice;
- Baseline assessment of landscape and visual resources (consisting of desk study, field survey and reporting) reviews the existing landscape and visual resource of the LVIA Study Area in terms of its character, quality (i.e., the baseline condition) and establishes sensitivity of the resources/receptors. The baseline assessment forms the basis against which to assess the magnitude and significance of the predicted landscape and visual effects arising from the Proposed Project;
- Layout and design optimisation, seeking to develop the design and layout of the Proposed Project based upon a combination of landscape and visual factors alongside, ecology, ornithology and peat constraints;
- Assessment of landscape and visual effects. The assessment describes the changes in the character and quality of the landscape and visual resources that are expected to result from the Proposed Project. In assessing landscape impacts, the potential direct effects on the fabric of the landscape are considered, together with the effects on the perception of landscape character. The baseline landscape character assessment together with an assessment of the effects on each character area is included in the assessment, along with consideration of the extent of potential significant effects. The visual assessment includes a viewpoint analysis which has been carried out to identify and evaluate the effects on visual amenity arising from the Proposed Project at specific representative locations in the LVIA Study Area; and,
- Assessment of in-combination effects sets out the scope of work undertaken for the assessment of the potential landscape and visual effects arising from the interaction of the separate elements of the Proposed Project.

13.4.4 Limitations of the standard approach include the use of agreed viewpoints as a proxy in order to understand effects across a wide area, and the limitations of the ZTV modelling, which can only be as accurate as the underlying data and the resolution at which this is available (50 m Digital Terrain Model).

Environmental Zone of Influence (EZI)

13.4.5 The LVIA Study Area is defined by a 15 km radius oval offset from the outermost edge of the Proposed Project, as shown in Drawing 13.1.1. This extent of LVIA Study Area was determined as appropriate, given the height of the Proposed Project, and agreed in consultation with the relevant consultees. A wider area was considered in terms of the effects of a launch; both areas falling within the overarching EZI for the AEE.

Process of Assessing Effects and their Significance

13.4.6 Once the baseline situation in relation to landscape and visual receptors has been reviewed, this information is combined with an understanding of the proposed change or development that is to be introduced, in order to identify and describe the landscape and visual effects. As the mitigation is embedded as part of the design, potential effects and residual effects will be the same. The assessment process determines whether the level of an effect will be significant or not through methodical consideration of, firstly, the sensitivity of landscape and visual receptors relative to changes as a result of the Proposed Project and, secondly, the magnitude of change that they will experience.

13.4.7 A more detailed description of the principles used in assigning sensitivity to change to landscape and visual receptors and evaluating the likely magnitude of change that will be experienced in relation to the Proposed Project, and in the subsequent consideration of sensitivity and magnitude in determining the level and overall significance of resultant effects, as informed by GLVIA 3, is set out in Appendix 13.1.

Level of Effects and Determination of Significance

13.4.8 The level of any identified landscape or visual effect has been assessed as major, moderate, minor or no effect, or intermediate categories (e.g., major/moderate) between these. These categories have been determined by consideration of the sensitivity of landscape or visual receptor and the predicted magnitude of change that will be experienced as a result of the Proposed Project, as summarised above and described in detail in Appendix 13.1, Volume IV. The following matrix in Table 13.2 is used as a guide to correlating sensitivity and magnitude to determine the level of predicted effects and their significance.

Table 13.2 - Significance of Effects on Landscape and Visual Receptors

Sensitivity	Magnitude of Change			
	Substantial	**Moderate**	**Slight**	**Negligible**
High	Major	Major to Moderate	Moderate	Moderate to Minor
Medium	Major to Moderate	Moderate	Moderate to Minor	Minor
	Moderate	Moderate to Minor	Minor	Minor to None

Low **Negligible**	Moderate to Minor	Minor	Minor to None	Minor to None

13.4.9 This assessment has been calibrated such that the threshold of significance in terms of AEE is major to moderate. In this assessment, moderate level effects, and those below this level are not considered to be significant. Where, for the purpose of this assessment, the landscape or visual effect has been classified as major or major/moderate, this is considered to be a significant effect.

13.4.10 The table is not used as a prescriptive tool, and the methodology and analysis of effects at any particular location must make allowance for the exercise of professional judgement. Thus, in some instances, a particular parameter may be considered as having a determining effect on the analysis.

Supporting Graphics

13.4.11 The LVIA is supported by a range of Drawings including viewpoint photography. These have been prepared in adherence to the principles presented in the Landscape Institute's Advice Note *TGN 06/19 Visual Representation of development proposals,* GLVIA3, and Naturescot's, *Visual Representation of Wind Farms*, Version 2.2, 2017.

13.5 Baseline Conditions

13.5.1 This section provides a general description of the landscape and visual context of the Proposed Project site and LVIA Study Area. It briefly describes the historical and cultural context within the LVIA Study Area, identifying both sensitive locations and receptors to be addressed in the subsequent impact assessment.

The Application Site

13.5.2 The location of the Proposed Project is shown in Drawing 13.1.1.

Proposed Project

13.5.3 The Proposed Project is located between Inner Skaw and Lamba Ness on the peninsula which extends east into the North Sea to the north east of Norwick on Unst. The peninsula falls into the Coastal Edge landscape character area (LCA), to the east of the Major Uplands LCA, as identified on the online NatureScot data: Scottish Landscape Character Types Map and Descriptions. The surrounding seascape is described in the Shetland Coastal Character Assessment (2016), falling within the East Unst coastal character area (CCA).

13.5.4 The broad, flat, grassed headland, now used for rough grazing, is accessed via a narrow tarmac track, with a regular scattering of derelict buildings and bunkers which formed part of the extensive former Skaw Radar Station. The complex of c.50 buildings and structures is now designated as a scheduled monument. At the edges of the peninsula the land falls away steeply through steep cliffs to the surrounding sea, with frequent sea stacks, skerries and inlets with the constant movement of waves and wind. The peninsula is seen against the backdrop of the rising uplands at Saxa Vord to the west, with expansive views across the sea at Nor Wick to the Hill of Clibberswick and island of Balta to the south, and the headland at Blue Jibs and the Holm of Skaw to the north.

13.5.5 The peninsula lies at c.11 m AOD, rising to high point of 31 m AOD at Lamba Ness. To the west the land begins to rise at Skaw, reaching c.60 m at the minor road (Holsens Road), rising steeply beyond to the Ward of Norwick to the west at 181 m AOD.

The Wider LVIA Study Area

13.5.6 The wider LVIA Study Area includes the exposed upland landscapes to the north and west with the Herma Ness headland to the north west and the adjoining uplands around Saxa Vord to the north east; the pronounced north-south ridge bounds the LVIA Study Area along the western side of Unst at Valla Field. These upland landscapes contrast with the more sheltered central and eastern landscapes, with the long north – south central valley and rolling hills of central Unst, and the settled farmland along the east coast at Balta Sound, Nor Wick and Harold’s Wick. Topographical elevations range from 0 m to c.250 m Above Ordnance Datum (AOD).

General Characteristics and Features of the LVIA Study Area

Extent of the LVIA Study Area

13.5.7 The 15 km radius LVIA Study Area, focussed on north-eastern Unst, encompasses the northern and middle extent of the Island of Unst and the archipelago of islets.

Topographical Features

13.5.8 The western edge of Unst comprises a linear ridge of higher ground between Hermaness Hill (200 m AOD), Snuega (131 m AOD) and Valla Field (216 m AOD), dominated by peat moorland. This ridgeline shelters the undulating eastern portion of the island which is interspersed with areas improved grassland, rough grazing and heathland. The interlocking network of hills including Saxa Vord (250 m AOD), Ward of Norwick (186 m AOD), Housi Field (122 m AOD) and the Hill of Clibberswick (160 m AOD) frame the core of the LVIA Study Area at Skaw, Lamba Ness and Norwick. The lower lying and sheltered land to the east around the coast, voes and sounds, as well as inland valleys are settled, with areas of enclosed farmland.

Natural Heritage Features

13.5.9 The LVIA Study Area covers a diverse range of landscapes, encompassing coastal, maritime, lowland and upland areas that support a variety of flora and fauna. In addition, the geology of the region provides a broad range of sites of geological and geomorphological interest. The key natural heritage attributes can be broadly summarised as follows:

- upland/moorland habitats;
- rock outcrops;
- areas of acid grassland;
- littoral habitats;
- intertidal habitats; and,
- maritime habitats.

13.5.10 The non-porous nature of the metamorphosed sedimentary bedrock, the presence of boulder clay and the cool and damp climate have combined to create large expanses of peatland across the ridgeline along the western edge of Unst. The eastern area of Unst has an undulating landform with Serpentine and Greenstone bedrock, often close to the surface, with a surface layer of shattered rock and glacial drift. There are areas of improved grassland, good rough grazing land and heathland without peat, resulting from the nature of the underlying rock.

13.5.11 The eastern area of Unst has particular geological interest, formed from a fragment of the ancient Lapteus Ocean. The unusual serpentinite rocks are a focus for local geological interpretation, giving rise to a strange landscape of peat free rusty-brown crags, with rare minerals, flower-rich heathland and bare gravel that supports rare plants.

13.5.12 There is comparatively little farmland, with small pockets of improved and rough grassland concentrated along the coastal strip, around voes, inlets and along valleys, related to areas of boulder clay and other glacial drift deposits.

Archaeological Features

13.5.13 The LVIA Study Area has a long cultural history with evidence of man's actions extending over some 8,000 years. Neolithic and Bronze Age settlement occurred in more favourable climatic conditions and as a result, occupied diverse locations across the islands. Subsequent patterns of settlement and land use have exploited the most productive land on the lower slopes of sheltered coasts and voes, benefitting from access to both hills for grazing and the sea for fishing and transport.

13.5.14 There are 392 Scheduled Monuments in Shetland ranging from Bronze Age burial chambers to later medieval features and Second World War defence infrastructure. The following Scheduled Monument sites are located on or close to the site:

- Skaw, radar station: The monument comprises the remains of a Second World War Chain Home radar station. The station is spread over two sites, a main and a reserve site, with over 50 buildings and structures reflecting its core early warning function and with supporting infrastructure and domestic blocks. It is located on rough grazing land over two headlands. Within the Proposed Project site at Lamba Ness and at Blue Jibs to the north; and,
- Inner Skaw, houses and field system, Unst: The monument comprises the remains of a series of farmhouses, the earliest of which may be of early Norse date, and a nearby series of abandoned fields of various dates and forms which would have been associated with different phases of the farming settlement.

13.5.15 More information on Material Assets and Cultural Heritage is detailed in Chapter 14, but these features are noted here as visitors are attracted to them and are potential visual receptors.

Built and other Heritage Features

13.5.16 Other important sites which may attract visitors, and hence be of relevance as potential visual receptors within the LVIA Study Area include:

- Skaw, Boat-Roofed Shed – Category C Listed Building: Outbuilding to N of Skaw Cottage comprising roughly oval battered random rubble base with door centred to SE side, roofed with over-turned and tarred former lifeboat.
- Norwick, The Banks, including cottage, outbuilding, ruin, boundary and sea walls – Category C Listed Building: Group of crofting buildings, dry stone walls and sea wall with a traditional character.
- Unst Heritage Centre, Haroldswick;
- Unst Boat Haven;
- Cromite Horse Mill at Hagdale; and,
- Viking Unst: The Shetland Amenity Trust promote the understanding and interpretation of the period of Viking settlement in Unst. This includes interpretation, display and a sequence of trails. Specific sites relevant to the LVIA Study Area include:
  - The Skidbladner (replica Gokstad ship), and the Viking Longhouse reconstruction, both located at Haroldswick.
  - Harald’s Grave, on the hillside above Harold’s Wick.

Settlement

13.5.17 The extensive upland and exposed coastline to the north-west of Unst is uninhabited. The climatic conditions place a strong emphasis for settlement in areas where the landform affords shelter from the high winds. The sheltered voes, sounds and inland valleys are, as a consequence, extremely important and these areas have been the focus for continued settlement and activity since the Iron Age. The adjoining productive low-lying land between the moorland hills and the sea, providing for grazing and fishing respectively.

13.5.18 Unst retains this traditional settlement pattern. In northern Unst, settlement is focussed on the low-lying land between Burra Firth, Harold’s Wick and Nor Wick with clusters of settlement at Haroldswick, Valsgarth and Norwick with scattered farming settlement between. Through mid Unst settlement is focussed through the lowlands around Balta Sound and the farming lands to the west with the main centre of settlement at Baltasound.

Roads

13.5.19 Roads have replaced the sea as the main way of travel. In the recent past many of the smaller winding roads have been straightened and widened and the engineering works associated with road upgrades has had a considerable effect on the character of the landscape in places.

13.5.20 The main A698 road, crosses Unst from the ferry port at Belmont in the south (receiving traffic from the mainland and Yell) and connects to Baltasound in the north-east. This road has been upgraded and forms an intrusive corridor through the wild landscape of the interior with modified vegetative cover related to the road's verges cuttings and embankments. The B9087 connects Baltasound to Valsgarth and settlement on the north-east coast of Unst; and B9086 connects to Burrafirth in the north. Minor spur roads connect to the smaller hamlets along the coastlines.

Cycle Network

13.5.21 National Cycle Route 1 connects from Sumburgh in the south of Mainland through to Skaw in north-eastern Unst. On Unst, the route follows the main road, A968 and continues on the B9087.

Walking Routes

13.5.22 There are no national walking routes defined on Shetland however, there are extensive opportunities for walking throughout the islands. Shetland Islands Council has designated a core path network to provide a reasonable level of public access in the Shetland Core Paths Plan. Key routes on Unst relevant to the Proposed Project include a loop around Clibberswick Hill, a route at Haroldswick and a circular route at Hagdale.

13.5.23 A longer linear core path provides access to the north-western coastline and Hermaness Hill from Burrafirth and a linear route from Houlland at the southern edge of the Loch of the Cliff through to Woodwick.

Tourism and Recreation

13.5.24 Many tourists travel to Unst as one of their main destinations on Shetland. Opportunities for tourism and recreation within the LVIA Study Area focus on outdoor pursuits such as walking, sea kayaking, bird watching, fishing, and visiting the numerous archaeological sites and geoparks. These activities tend to take place in the coastal areas enjoying the dramatic contrasts between sea, sky and land.

13.5.25 Visitor attractions on the island include important areas for bird watching on the coastal nature reserves around Herma Ness, Saxa Vord and Muckle Flugga stacks on the north and north-western coasts of Unst. At Baltasound the Unst Boat Haven and Unst Heritage Centre are a focus for tourist visits. Informal visitor attractions in the LVIA Study Area include the beaches at Norwick and Skaw.

Baseline Landscape Resources

13.5.26 The character and value of the LVIA Study Area has been reviewed in greater detail against existing landscape character assessments, landscape designations, and other relevant non-designated areas, as set out below.

Landscape Character Assessment

Scottish Landscape Character Types Map and Descriptions Online (NatureScot, 2020)

13.5.27 NatureScot has used a system of landscape character assessment to identify, describe, classify and map Shetland. Using accepted, systematic methods of landscape character assessment, the countryside has been subdivided into different Landscape Character Types (LCTs) and Landscape Character Areas (LCAs), each with a distinctive character based upon local patterns of geology, land form, land use, cultural and ecological features. These provide information that can be used to guide landscape change and provide a baseline against which to make judgements on the likely effects of the Proposed Project upon landscape character.

Shetland Coastal Character Assessment, NAFC Marine Centre (NAFC), 2016

13.5.28 In addition to the landscape character areas, the NAFC Marine Centre has prepared the Shetland Coastal Character Assessment, 2016 which provides a characterisation of the Shetland seascape. The coastal character assessment identifies and maps different Coastal Character Areas (CCAs).

An assessment of the sensitivity and capacity of the Scottish seascape in relation to offshore windfarms, Scottish Natural Heritage Commissioned Report No.103, 2005

This document defines seascape character types around the Scottish coast, combining coastal and marine character to define seascape character.

13.5.29 These studies provide an assessment of the landscape, seascape and coastal character of the area, and consider the likely pressures and opportunities for change in the landscape / seascape. The LCTs, SCAs and CCAs that fall within the 15 km radius LVIA Study Area are illustrated in Drawing 13.1.3 Volume III and described in detail in Appendix 13.2, Appendix 13.3 and Appendix 13.4 respectively.

13.5.30 The Proposed Project includes parts of the 355 - Coastal Edge LCT and 349 - Major Uplands LCT as identified in the Scottish Landscape Character Types Mapping.

13.5.31 The Coastal Edge Landscape Type is described as follows:

"The dramatic Coastal Edge Landscape Character Type occurs in several narrow strips around the exposed, mainly rocky coastline of Shetland. It forms the edge of upland and lowland Landscape Character Types, and includes dramatic coastal features, including towering sea cliffs, stacks and natural arches."

13.5.32 Key characteristics of the Coastal Edge LCT are described as follows:

- *"Narrow, indented coastal edge of rocky headlands, inlets and promontories on exposed parts of the coast.*
- *Mainly high to moderately high cliffs with frequent features of coastal erosion including stacks, arches, blowholes, caves and storm beaches.*
- *Diversity of colour and rock forms derived from the wide variety of bedrock.*
- *Short, colourful swards of maritime heath and grasslands on cliff tops and some sheltered cliffs, with bare, scoured rock in exposed locations.*
- *Many prehistoric and wartime archaeological relics revealed in short grassy landcover.*
- *Diverse and dramatic coastal scenery with a variety of coastal views.*
- *Remote, exposed, open and highly natural landscape with wild character."*

13.5.33 The Major Uplands Landscape Type is described as follows:

"The Major Uplands Landscape Character Type occurs as several upland hill masses incorporating the highest land in Shetland, forming the main physical structure of Shetland. The Landscape Character Type occupies large parts of central and south Shetland Mainland, with western and eastern outliers at Bressay, Sandness Hill, Ronas Hill, Foula, Fair Isle and in the north at Unst. The landcover is dominated by peatland and heather moorland peaty mires."

13.5.34 Key characteristics of the Major Uplands LCT are described as follows:

- *"Rounded hills, occurring either in series connected by high level rounded ridges along a linear band, or as isolated single hills or hill groups.*
- *Often steep slopes at the coast, or cliff edges with dramatic natural coastal landforms.*

- *Mainly simple landcover of peat bog and heather moorland grading to rough grassland on some lower slopes, contrasting with the ordered fields of adjoining lowlands and the intricate coastline.*
- *Hill grazing and low-key peat cutting.*
- *Mainly uninhabited and often difficult to access on foot or by road, with roads mainly absent on higher land.*
- *Exposed high land with panoramic views, forming landmark features which themselves are often visible for miles.*
- *Relatively expansive, although scale is difficult to discern and reduced by the*
- *presence of manmade structures.*
- *A sense of remoteness and wild character in places."*

13.5.35 The Farmed and Settled Voes Landscape Type is described as follows:

"The Farmed and Settled Voes and Sounds Landscape Character Type occurs in Shetland around the enclosed coastal waters which are distributed around most parts of the islands... They are dominated by pasture and rough grassland resulting from long established farming. The type includes Shetland's main towns and many harbour settlements. Along with the Farmed and Settled Lowlands and Coasts, these areas constitute the majority of Shetland's most productive farmland."

13.5.36 Key characteristics of the Farmed and Settled Voes LCT are described as follows:

- *"Narrow, low lying coastal strips of gently sloping or undulating land around enclosed waters.*
- *Complex, indented coastline which provides shelter.*
- *Mainly agricultural land use on improved and unimproved pastures with heathland, wetland and wet pastures which add variety.*
- *Unusual grassland and heathland on base-rich soils on Unst and Fetlar.*
- *Scarce broadleaf tree cover found in very small remnant woodland patches and recent plantations.*
- *Mostly traditional crofting in linear or scattered patterns, with some estates.*
- *Larger settlements around harbours with historic built heritage.*
- *Mainly inland, minor road network with branches to beaches and harbours.*
- *Abundant archaeology across all periods of human settlement.*
- *Rural areas provide a contrasting backdrop and setting for settlements.*
- *Rural areas and settlements contrast with the surrounding, large scale hill land.*
- *Views are ever-changing due to the complex coastline and interlocking landforms.*
- *Remote settlements have a strong sense of isolation and tranquillity."*

13.5.37 In undertaking the preliminary assessment and review of baseline material against the visibility mapping of the Proposed Project, and through subsequent fieldwork, it is considered that (leaving aside a launch which will have wider visibility and is considered separately), beyond a 15 km radius the Proposed Project will be seen as a distant element in the landscape and that there will be only a limited influence on the characteristics, defining features and/or special qualities of the LCTs/SCAs/CCAs. Although there may be some effects on landscape character beyond a 15 km radius from the Site, these are not likely to be significant and, in this regard, LCTs/SCAs/CCAs (as well as sub units of the Shetland NSA, WLAs and LLAs) beyond 15 km of the Proposed Project Site have not been assessed further. LCTs/SCAs/CCAs within a 15 km radius of the Proposed Project have been reviewed in detail and provide an appropriate basis to describe the landscape/seascape/coastal character of the area surrounding the Proposed Project.

13.5.38 There are 12 LCTs/SCAs/CCAs within 15 km of the Proposed Project. Of these CCA 13 Bura Firth, Unst, CCA 19, Hermaness, and SCA 1: Remote High Cliffs will experience limited or no visibility to the Proposed Project and have therefore not been considered further in this assessment.

13.5.39 The nine remaining LCTs/ SCAs/CCAs have the potential to be significantly affected by the Proposed Project, as listed in Table 13.3 and are included in the detailed assessment reporting in Section 13.7.

Table 13.3 Summary of LCTs / CCAs within 15 km of the Proposed Project and within the Zone of Theoretical Visibility

Landscape Character / Seascape / Coastal Character Area (CCA)	Source	Value	Susceptibility	Overall Sensitivity to Change Associated with the Proposed Project
349 Major Uplands	NatureScot Online Maps and Descriptions	High	High	High
350 Peatland and Moorland	NatureScot Online Maps and Descriptions	Medium	Medium	Medium
352 Inland Valleys	NatureScot Online Maps and Descriptions	Medium	Medium	Medium
353 Farmed and Settled Lowlands and Coast	NatureScot Online Maps and Descriptions	High	Medium	High Medium
354 Farmed and Settled Voes and Sounds	NatureScot Online Maps and Descriptions	Medium	Medium	Medium
355 Coastal Edge	NatureScot Online Maps and Descriptions	High	Medium	High Medium
CCA 16, East Unst	SCCA, NAFC 2016	High	High	High
CCA 20, Skaw	SCCA, NAFC 2016	High	High	High
Seascape Character Type 13 D: Islands, Sounds and Voes	Sensitivity and Capacity of the Scottish Seascape, NatureScot, 2005	High	High	High

Landscape Designations and Other Relevant Areas

13.5.40 Landscape designations are important in the context of the LVIA with regard to the effects of the Proposed Project on the landscape quality and visual amenity of designated areas within the LVIA Study Area.

13.5.41 Landscapes designated at the national scale include National Scenic Areas (NSAs). Local Landscape Areas (LLAs) are designated by Shetland Islands Council. The location and extent of these designations within the LVIA Study Area are shown in Drawing 13.1.2 and are described below.

National Scenic Areas

13.5.42 Within Scotland, NSAs are areas of outstanding scenic value in a national context. There are 40 designated NSAs in Scotland, which cover approximately 13% of Scotland, with policies for protecting the NSAs set out in development plans. In 2007 and 2008 SNH, working in partnership with Historic Scotland and the Royal Commission on the Ancient and Historical Monuments of Scotland (RCAHMS), surveyed all NSAs to list the landscape qualities that make each special, as set out in *The Special Qualities of the National Scenic Areas*, Scottish Natural Heritage Commissioned Report No.374, 2010.

13.5.43 Seven small areas of coastal landscape in Shetland have been identified as being of outstanding scenic interest. These designated areas that make-up the Shetland NSA comprise Shetland's scenic highlights and epitomise the range of coastal forms varying across the island group.

13.5.44 One NSA sub-unit, Hermaness, is located within the LVIA Study Area. The identified special qualities of the Hermaness sub-unit are as follows:

- "The stunning variety of the extensive coastline;
- The hidden coasts;
- The effects and co-existence of wind and shelter;
- A sense of remoteness, solitude and tranquillity;
- The notable and memorable coastal stacks, promontories and cliffs;
- The distinctive cultural landmarks; and
- Northern light."

13.5.45 The following additional notes relevant to the special qualities for the Hermaness NSA sub-unit are set out in the report:

"The stunning variety of the extensive coastline

At Hermaness on Unst, the coastal topography varies from the 175m high cliffs at the Neap, to the sandy beach and machair at the head of the narrow Burrafirth.

The notable and memorable coastal stacks, promontories and cliffs

Where open to the full fury of the Atlantic Ocean, the sea has carved impressive cliffs, forming spectacular, towering, vertical scenery, varying greatly in colour according to the complex geology.

The coast also contains many distinctive stacks, promontories and other features that form memorable images. Within the NSA these include:

The imposing cliffs of Hermaness itself, with its nesting seabirds."

Local Landscape Areas

13.5.46 In 2014 Shetland Islands Council published the Current Local Landscape Areas, as draft supplementary planning guidance. This document which follows on from the Shetland Local Landscape Designation Review, 2011, sets out for each of the proposed Local Landscape Areas (LLAs): the location and boundaries; the key characteristics; a designation statement; and provides development guidelines.

13.5.47 Three LLAs are identified within the LVIA Study Area. Analysis of the ZTV indicates that there is very limited very long-distance visibility (in excess of 15 km), or no theoretical visibility of the Proposed Project from two of the LLAs that lie within or overlap with the LVIA Study Area, as follows:

- Colvadale and Muness, Unst LLA: A small are of distant visibility from Muness, at distances of c.15 km; and,

- Gloup Voe and Bluemull Sound LLA: No visibility.

13.5.48 Owing to the very limited and long-distance nature of visibility, or absence of visibility, these LLAs will not be affected by the Proposed Project to a level that could result in significant effects therefore, they have not been considered further as part of this assessment. The draft designation statements for the remaining LLA at Haroldswick and Skaw taken from Current Local Landscape Areas, 2014 are set out below.

Proposed LLA 15: Haroldswick and Skaw

"Key characteristics:

- *Part of the most northerly area of Shetland and Britain*
- *Highly visible military defence infrastructure, including active and disused elements*
- *Rugged, exposed northern coast, with sheltered sandy bays*
- *Rich geology visible at the surface*
- *Actively settled area undergoing redevelopment as former military uses decline and new uses are found."*

Designation statement:

"This is a rugged landscape with a great variety in landform. The rocky headlands and dramatic folded cliffs of the north coast are topped with moorland, contrasting in its smoothness. This moorland continues upwards to a group of rounded hills, the highest being Saxa Vord."

Inventory Gardens and Designed Landscapes

13.5.49 The Inventory of Gardens and Designed Landscapes in Scotland is a list of nationally important Gardens and Designed Landscapes (GDLs) that meet the criteria published in Historic Scotland's 2011 publication, Scottish Historic Environment Policy.

13.5.50 Belmont House lies approximately 18 km from the Proposed Project and is screened from direct views. Effects will not be significant and have not been considered further in this assessment.

13.5.51 Table 13.4 below sets out a summary of the designated landscapes considered in the assessment and their sensitivity to the Proposed Project.

Table 13.4 - Summary of Landscape Designations within the Zone of Theoretical Visibility

Landscape Designation	Value	Susceptibility	Overall Sensitivity to Change Associated with the Proposed Project
Hermaness National Scenic Area	High	High	High
Haroldswick and Skaw, Local Landscape Area	High/Medium	Medium	Medium

Baseline Visual Resources

13.5.52 A key component of the assessment is the consideration of effects from key locations within the LVIA Study Area. This assessment is undertaken through analysis of visibility mapping and confirmation of the extent of visibility, through the preparation of wireframes and use of these in the field in combination with photomontages.

Settlements

13.5.53 Settlement within the LVIA Study Area is located in sheltered locations close to sheltered voes and sounds, typically comprising open settlements and dispersed aggregations of crofts.

13.5.54 In accordance with the criteria outlined in the detailed methodology in Appendix 13.1, residential receptors within settlements have a high susceptibility to change as views are experienced regularly for prolonged periods. Residential receptors are generally considered to have a high sensitivity overall to the Proposed Project.

13.5.55 The following table lists the principal areas of settlements into the zone of theoretical visibility of the Proposed Project where significant effects may arise, as illustrated in Drawings 13.2.1-13.2.2. and identifies those settlements which require further assessment.

Table 13.5 - Summary of Settlements within the Zone of Theoretical Visibility

Settlement	Distance and Direction to Proposed Project	Theoretical Visibility of the Proposal
Within 5 km of the Launch Pads		
The Haa, Skaw	c.750 m to Proposed Project boundary	No visibility.
Booths/Houlanbrindy	c.660 m to Proposed Project boundary	Partial visibility to the integration hangars, boundary fencing, tracking station, launch vehicles and lightning masts.
Norwick/Kirkaton	c.1.2 km to Proposed Project boundary	Partial visibility to the gate house, integration hangars, boundary fencing, tracking station, launch vehicles and lightning masts.
Valsgarth/Saxa Vord	c.2.3 km to Proposed Project boundary	Partial visibility to the gate house, integration hangars, boundary fencing, tracking station, launch vehicles and lightning masts.
Haroldswick	c.3.2 km to the Proposed Project boundary	No visibility.
Ungirsta/Stove	c.3.5 km to the Proposed Project boundary	No visibility.
Within 10 km of the Launch Pads		
Burrafirth Cluster	c.4.36 km to Proposed Project boundary	No visibility.
Quoys	c.4.46 km to Proposed Project boundary	Uninhabited.
Baltasound Cluster (closest location at bus garage)	c.5.29 km to Proposed Project boundary	No visibility.
Within 15 km of the Launch Pads		
Westing Cluster	c.13.4 km to Proposed Project boundary	No visibility.

Routes

13.5.56 Vehicular and non-vehicular route corridors within the LVIA Study Area, include roads and designated cycle routes. The following table lists route corridors within 15 km of the Proposed Project, falling within the zone of theoretical visibility, as illustrated in Drawings 13.2.1-13.2.2. The table identifies which routes or parts of routes require further assessment.

Table 13.6 - Review of visibility from Routes within the LVIA Study Area

Route	Theoretical Visibility of the Proposal
A968 (National Cycle Route 1)	No visibility to Proposed Project; no visibility south of Hagdale.
B9086	Intermittent visibility from higher ground around Ungrista to Proposed Project; limited visibility elsewhere - Included in the detailed assessment.
B9087 (National Cycle Route 1)	Extensive visibility north of Valsgarth/Saxa Vord to the Proposed Project- Included in the detailed assessment.

Viewpoint Selection

13.5.57 Viewpoints for the visual assessment were identified following production of the ZTV and a list of viewpoints were selected and confirmed with consultees as part of the scoping exercise, as summarised in Section 13.3. The types of receptors considered included the following:

- different LCTs/CCAs/SCAs;
- designated and other sensitive landscapes;
- settlements (towns and villages, as well as smaller groups of residential properties);
- roads (main and minor);
- footpaths and cycle routes including Core Paths and the National Cycle Network (NCN) Routes;
- marked/ popular viewpoints;
- other outdoor recreational resources (including frequently visited historical and archaeological sites); and,
- visitor/ tourist facilities such as camp sites, hotels and visitor attractions.

13.5.58 In order to confirm the appropriateness of the viewpoint selection, field survey verification was carried out. This involved checking the viewpoint grid references on the ground, to ensure that there will be views of the Proposed Project from these locations.

13.5.59 The viewpoints taken forward for full assessment include 21 viewpoints that cover a range of representative landscape and visual receptors, distances from the Proposed Project, altitudes and directions, with the aim of achieving a reasonable distribution at compass points around the application site. Viewpoints were visited as part of the baseline visual assessment, and panoramic photographs of the existing views were taken. The final list of viewpoints, agreed through written correspondence with Shetland Islands Council and SNH, is shown in Table 13.7, and their locations are illustrated in Drawing 13.1.4. Photographs of the existing views from these viewpoints are shown in Drawings 13.3.10.1 – 13.3.2.5. The existing and predicted views of the Proposed Project are described in the assessment of effects in Section 13.8.

Table 13.7 – Selected Viewpoints

No.	Viewpoint Location	Distance and Direction to Proposed Project	Receptors	Grid Reference
Viewpoints to the Proposed Project				
1.1	Bluejibs above the Wick of Skaw	1.1 km to the south.	Local Landscape Area and recreational walkers, representative of views from the north-east coast of Unst.	466309, 1216806
1.2	The Haa, Wick of Skaw	860 m to the south.	Local Landscape Area and residential settlement.	465968, 1215187
1.3	The Garths, Lamba Ness	320 m to the east.	Local view to the launch pads.	465405, 1215187
1.4	Car park at The Taing, Norwick	800 m to the north east.	Local Landscape Area and residential settlement.	465172, 121459
1.5	The cemetery, Norwick	1.2 km to the north.	Local Landscape Area and residential settlement.	465188, 1214128
1.6	B9087 Norwick	1.6 km to the north east.	Local Landscape Area and residential settlement.	464872, 1213830
1.7	Hill of Clibberswick	2.4 km to the north.	Local Landscape Area and recreational walkers.	466351, 1212904
1.8	Hermaness Hill	5.32 km to the east.	National Scenic Area, Recreational walkers.	460648, 1217592
1.9	Lay by on A968 above Harold's Wick	4.4 km to the north east.	Road users and cyclists on NCR1. Recreational walkers.	463144, 1210817
1.10	Headland to the north of Saxa Vord radar station	3.3 km to the east.	National Scenic Area, Recreational walkers.	462970, 1217656

Other Baseline Built/ Consented Infrastructure

13.5.60 At the time of writing, other significant infrastructure development within the 15 km LVIA Study Area is confined to the recent reactivation of the Saxa Vord remote radar head. The Royal Air Force radar station is named after Saxa Vord which is the highest hill on Unst at 285 m AOD. The infrastructure at Saxa Vord includes the remains of the Saxa Vord radar station built in 1941, the access tracks, the associated radar infrastructure to the north of Saxa Vord and to the east at the Ward of Norwick, and the former RAF camp and domestic accommodation buildings at Valsgarth/Saxa Vord which are now privately owned as the Saxa Vord Resort complex. The remains of the former Skaw Radar Station, also built in 1941, are scattered across the peninsula of land between Inner Skaw and Lamba Ness, comprising the Skaw scheduled monument site. As this infrastructure is already part of the current landscape and visual baseline resource it is considered as an integral part of the baseline within the main assessment of landscape and visual effects in Sections 13.7 and 13.8.

13.6 Assessment of Effects

13.6.1 This section comprises the assessment of the effects on landscape and visual resources arising from operation of the Proposed Project.

13.6.2 The Applicant is looking to achieve a maximum of 30 RepLV launch events per year from the Proposed Project. Of the total proposed launches per year, when taking into account the no-launch window agreed between mid-May to the end of June, the Applicant anticipates that in any one month there may be up to four RepLV launch events, on the basis that there will likely be a period of a week between launches due to operational constraints within the launch vehicle assembly facilities.

13.6.3 Whilst the Applicant has not yet determined a specific timeframe for operations, when required for the purposes of this AEE an operational period of 30 years has been assumed, aligning with the current land lease for the Proposed Project.

13.6.4 The effects can be thought of as ‘residual’ effects because they take into account embedded mitigation measures included already in the previous design and construction stages of the Proposed Project, as summarised below.

Existing ‘Embedded’ Mitigation

13.6.5 Design iteration of the Proposed Project was undertaken as part of the LVIA at the planning stage to reduce the visual effects. The assessment for AEE has, therefore, been completed taking into account the following embedded mitigation measures.

Topography and Landform

13.6.6 The buildings and roads will be sited to minimise the requirement for major ground modelling thereby reducing the extent of earth moving and the need to alter the existing landform within the site. This will have the added benefit of reducing, or indeed, negating the need to remove surplus material from the site.

Massing and Form

13.6.7 Through careful site planning an integrated relationship has been developed between the proposed buildings and infrastructure and the existing site roads and former radar infrastructure, which are listed as scheduled monuments, to create a simple harmony that builds on the existing grain of the landscape and fits the Proposed Project sensitively between existing structures.

13.6.8 Visual integration will be secured through orientation, positioning of buildings and structures, profile, colour and facade treatments, design detailing, use of materials, use of land profiling, all selected to give cohesion to the Proposed Project and create an appropriate response to the components of the surrounding landscape and be seen as an appropriate addition in the context of the existing site elements and infrastructure. A summary of the development and design strategy for the main building groups is set out below.

Inner Skaw Assembly Building Cluster

13.6.9 The western sector of the Lamba Ness site at Inner Skaw is set aside for a cluster of buildings which will form the entrance area to the Proposed Project. A new gate house will control access to the site at the western limit of the site and will also provide visitor facilities and information about site access and interpretation. Access will lead from this point from an upgraded road following the existing track to provide general site access. A new side road will lead to an area set aside for the launch vehicle assembly and the storage of materials with associated hard standings. This cluster of buildings will include: an administration building, 6 m high and with a footprint of c. 20 m x 20 m; two adjacent large hangars rising to c. 13 m, with a footprint each of c. 29 m x 63 m; a small pyrotechnics store; a hazardous Materials Store 5 m high, with a footprint of 13 m x 13 m; and a small substation.

13.6.10 The detailing of the gate house differs slightly from the hangar and storage buildings to draw it apart from the main cluster, and to foster a sense of arrival and welcome to the site.

Satellite Tracking Station

13.6.11 Mid-way along the site, a satellite tracking station is proposed. This will include an area of hardstanding and four separate telemetry devices, housed within geodesic radomes.

Integration Hangar

13.6.12 The integration hangar, a large building rising to c.14 m, with a footprint of c.61 m x 41 m, will be located to the south of the three launch pads and the main access track. The hangar is linked to the launch pads through the upgraded access track and the new tracks leading to each of the separate launch pads.

Launch Pads

13.6.13 Three separate launch pads are proposed. Launch Pad 1 will be positioned to the northern side of the Lamba Ness peninsula, carefully set between the structures of the radar station. Some of the former radar station structures will need to be carefully removed to accommodate the new launch pad structures. Two more launch pads are proposed on the northern side of The Garths, spaced approximately 180 m apart and integrated as far as possible between the substantially retained structures of the former radar station.

13.6.14 Each launch pad will comprise a central area of hard standing flanked by earth sheltered gabion walls which shelter further areas of hardstanding where temporary control buildings, storage containers and fuel stores will be placed during the course a launch cycle. When the launch pad is not in use these temporary building and containers will not be present on the site.

13.6.15 The launch pad will have at its centre a simple permanent pedestal and gantry to receive the launch vehicle. The apparatus used during the launch cycle to erect the launch vehicle will be brought to site as mobile and temporary equipment for each launch.

13.6.16 Permanent lightning masts will be positioned either side of the launch pad, comprising telescopic towers which will be extended during a launch to their operational height of 46 m. At all other times the lightning masts will be retracted to their un-extended configuration of 25 m. As with other permanent structures on the site they will be finished in a recessive grey colour.

13.6.17 Adjacent to each launch pad will be a water tank / pump house to deliver water inundation during each launch cycle. The dimensions, base heights and overall heights for the structures are as follows: water tank 4 m x 4 m x 2 m high located at ground level; pump house 10 m x 6 m x 4 m high (to apex).

13.6.18 The earth sheltered bunds comprise a grassed earth bund on the inner face and rock filled gabion walls on the outer faces. The grassed faces will be vegetated with grass turves won from the site. The gabion walls will be filled with locally won rock to ensure effective integration with the surrounding rock type seen in the surrounding landscape and coastline. These measures will ensure that the simple structure of the launch pad sites will recede in views against the wider setting and marry in with the existing structures of the former radar station.

13.6.19 A wildlife hide is proposed to the east of Launch Pad 3 on the eastern edge of Lamba Ness.

Colour

13.6.20 The clusters of new buildings at Lamba Ness will be given unity by use of similar colour themes and colour palettes that draw upon colours seen in buildings across Unst and natural colours occurring within the local Unst landscape. The red hues proposed in buildings are based on those colours seen in the: minerology of the landscape; the tan colours of the surrounding grassland and cut hay meadows; and in local buildings such as the painted barns and the large hangar at Baltasound Airport.

13.6.21 The graduation of colours in the elevations is intended to assist in breaking up the elevations of the larger buildings, with a transition from red, through tan, to the cool grey tones seen in the fast-moving cloudscape, a colour which will also be seen reflected in the foreground of the surrounding seascape.

Lighting

13.6.22 Lighting has been considered as an important element of the Proposed Project. Potential light sources will be associated with flood lighting for the launch pads during launch cycles and cut off lighting within the new network of external spaces around the proposed buildings, including car parking areas.

13.6.23 A sympathetic lighting strategy will be prepared within the context of the design of the buildings to minimise any potential adverse effects. A number of measures will be introduced within the context of the operational requirements of the site to minimise the unwanted effects associated with light sources. These will include:

- Cowls/shielding of lights to prevent glare;
- Minimisation of light spread through the use of directional lighting;
- Minimising the potential for sky glow by avoiding the potential for upward reflected light;
- Reducing the operational hours of the lighting to reduce the potential for disturbance; and,
- In some areas, intelligent dimming technology may be used to activate lighting through activity.

13.6.24 These measures are proposed to minimise light pollution and reduce night-time glare, while providing appropriate night-time illumination within the Proposed Project.

Services

13.6.25 All services associated with the Proposed Project will be routed underground and therefore, any visual effects will be limited to directional flood lighting units.

13.6.26 The site drainage strategy will, subject to the necessary agreements, be based upon roadside filtration trenches which are likely to include a combination of open swales and buried pipes/culverts and sustainable drainage systems.

Assessment of Effects on the Landscape Resource

13.6.27 The landscape resource is the distinctive physical pattern of components and features that combine to form and characterise the landscape. The effects of the Proposed Project on this resource are those that will directly alter this physical pattern and will thus have an effect on the character of the landscape. These effects will occur within the landscape character area in which the Proposed Project is located. Beyond this, changes to the landscape character will be confined to indirect changes to the landscape resource. The assessment of the effects on the landscape resource is subdivided into direct effects on the landscape resource and indirect effects on landscape character.

13.6.28 The following assessment of landscape effects addresses:

- Effects on the application sites;
- Effects on Landscape Character; and,
- Effects on Designated Landscapes

13.6.29 Identification of the potential for significant effects has been undertaken following a review of the visualisations provided in Drawings 13.3.1.1 to 13.3.2.5. This is in addition to comprehensive field work assessment and the use of computer-generated visualisations in order to inform the judgements made by the landscape professional undertaking the assessment.

Duration and Reversibility of the Landscape and Visual Effects

13.6.30 The magnitude of changes that will be experienced by receptors as a result of the Proposed Project relates in part to the duration of effects and their permanence/reversibility. The effects will be permanent on completion of the Proposed Project.

Effects During a Launch Sequence

13.6.31 The assessment of effects set out below is based on the configuration of the Proposed Project and its associated landscape and visual effects during the day to day operation of the Proposed Project. During the run up to and the launch of launch vehicles, there will be a range of additional landscape effects experienced during run up to and 'take off' sequence of a launch. These effects will largely be associated with the launch of the launch vehicle itself however, it is acknowledged that at certain times of year, and particularly during the summer tourist season, the launch of a launch vehicle in itself will be a notable attraction for tourists and visitors to Unst. Therefore, there are also likely to be additional short-term landscape and visual effects deriving from the attraction of visitors and associated traffic during their visits to the area.

Typical Characteristics of a Launch Sequence

13.6.32 Prior to the launch, temporary vehicles and containers will be moved into position within the earth sheltered areas of hard standing, beside the launch pad. As the launch vehicle is prepared for launch the launch vehicle will be taken from the Integration Hangar to the launch pad, and erected into a vertical position at the launch pad. The launch vehicle will be held in place with a 'strongback', a metal structure that supports the launch vehicle in an upright before it launches. In the same period the lighting masts will be extended to their maximum length. Close to the launch, as various propellants and fuels are loaded into the launch vehicle, there will be additional effects arising through the emission of occasional vapours from the launch vehicle and surrounding equipment, as well as the presence of activity and lighting. The launch vehicle may be at the launch pad for several days prior to launch and the launch vehicle and launch pad and surrounding structures will be brightly illuminated at night.

13.6.33 The launch of the launch vehicle itself will be very short in duration and give rise to a range of very short term but significant and widespread landscape and visual effects. As the launch vehicle ignites, a process of water inundation is commenced as a measure to both reduce the roar of the launch vehicle but also to protect the launch vehicle from its own flames. The resulting interaction of the flames and water will give rise to a localised plume of water vapour and smoke at the base of the launch pad. This will quickly dissipate after take-off and is expected to flow away to the north-east given the predominant wind direction.

13.6.34 The launch itself will be very quick, with the launch vehicle moving above the strongback within c.3 seconds of the initial launch vehicle firing, the overall noise and emissions reaching a peak up to 10 seconds into the launch, immediately reducing thereafter. The launch vehicle will be seen to speed away from the launch site, reaching an altitude of c.1 km after approximately 23 seconds into the launch, and c.2 km after approximately 30 seconds. There may at times be a visible trail or plume from the launch vehicle, however, it is expected that the principal feature of the lift -off will be the rapidly ascending cone of super-heated exhaust gases, immediately beneath the launch vehicle.

13.6.35 The short-term effects of the actual launch will give rise to temporarily significant but very short-term effects on landscape and visual receptors with primary visibility extending across northern areas of Unst, largely coincident with the landscape and visual receptors reviewed in the assessment of operational effects. The launch vehicle itself will be visible thereafter for much greater distances extending across Unst, for a very short period of time as it rises through the lower atmosphere; however, from these distances the launch and launch vehicle will appear very small, with the launch vehicle becoming visually smaller still as it travels up through the atmosphere. As such this is not considered to present a significant effect. In addition, the trajectory of all launches will arc away from the Shetland Islands to the north across the North Sea and therefore it is noted that direct visibility will rapidly decay.

13.6.36 These effects will give rise to short term changes in qualities of tranquillity experienced within the LVIA Study Area, giving rise to very short-term disturbance. It is noted that the LVIA Study Area is characterised by its wild remote qualities, the experience of tranquillity and the ability to 'get away from it all', and that many people living within and visiting the LVIA Study Area choose to visit and live here to find an escape.

13.6.37 The frequency of launches will increase once all three launch pads are operational, and whilst individual launches will be well separated, there will be an overall cumulative effect on general tranquillity within the LVIA Study Area. As such, whilst the effects of an individual launch will be short lived, it is noted that there will be an ongoing requirement to inform and consult on issues arising from launch sequences.

13.6.38 Following the launch, the strongback will be lowered and removed back to the TEL Hangar, the lightning masts retracted, and the temporary vehicles and containers removed from the launch pad site. The launch pad is expected to return to its normal configuration within a few days after launch.

Visitors

13.6.39 As discussed above, in the days running up to launches during the tourist season, there are likely to be a greater number of visitors to the surrounding area in the immediate few hours before and after a launch. This will give rise to short term effects of increased traffic and pedestrian movement, pressure for temporary car parking and localised aggregations of spectators. A Visitor Management Strategy has been developed by the Applicant.

13.6.40 Whilst the effects will be temporary, the increased visitor pressure will inevitably give rise to secondary localised landscape and visual effects at publicly accessible vantage points around the Proposed Project.

Assessment of Direct Effects on the Landscape Resource

Location

13.6.41 The baseline assessment identifies the gently sloping peninsula of land between Inner Skaw and Lamba Ness as the context for the Proposed Project forming the Proposed Project.

13.6.42 The main land use on the site is as pasture for sheep grazing, with subdivision by stock proof fencing and sections of drystone dyke into a series of large fields. Steep cliffs surround the coastal edge of the site, with a small area of the northern site shelving to a small beach at the Sand of Inner Skaw.

Landscape Sensitivity

13.6.43 It is considered that the sensitivity of the Landscape to change is Medium. The factors which have contributed to this judgement are as follows:

Value

13.6.44 Medium/High: The site lies within the Haroldswick and Skaw Local Landscape Area. The site area encompasses the Skaw Radar Station scheduled monument site.

Susceptibility to Change

13.6.45 The simple grassland across the site is not a scarce resource in this area and can accommodate the level of change proposed however, areas of wetland and the remaining structures within the scheduled monument sites are vulnerable to change and will be protected where possible.

Magnitude of Change

13.6.46 The overall magnitude of change to the existing landscape fabric across the site will be Substantial. The factors which have contributed to this judgement are set out below.

Size or Scale

Inner Skaw Assembly Building Cluster

13.6.47 The western sector of the Lamba Ness site at Inner Skaw is set aside for a cluster of buildings which will form the entrance area to the Proposed Project. This will include: a Gate house, 6.3m high, with a footprint of 17 m x 17 m; an administration building, 6 m high and with a footprint of c. 20 m x 20 m; two adjacent large integration hangars rising to c.13 m, with a footprint each of c. 29 m x 63 m; a small pyrotechnics store; a hazardous Materials Store 5 m high, with a footprint of 13 m x 13 m; c.3,250 m² of hard standing; and a small electricity substation.

Satellite Tracking Station

13.6.48 Mid-way along the Proposed Project, a Satellite Tracking Station is proposed. This will include an area of hardstanding and four separate telemetry devices, housed within geodesic radomes.

TEL Hangar

13.6.49 The transporter holding building, a large hangar rising to c.14 m, with a footprint of c.61 m x 41 m, will be located to the south of the three launch pads and the main access track.

Launch Pads

13.6.50 Three separate launch pads are proposed, one at Lamba Ness and two on the northern side of The Garths.

13.6.51 Each launch pad will comprise a central area of hard standing flanked by earth sheltered gabion walls which shelter further areas of hardstanding where temporary control buildings, storage containers and fuel stores will be placed during the course a launch cycle. Each launch pad extends to a footprint of approximately 100 m x 100 m.

13.6.52 A wildlife hide is proposed at the eastern edge of Lamba Ness to the east of Launch Pad 3.

Access Tracks

13.6.53 The disparate elements of the Proposed Project will be connected by an upgraded access track, which will predominantly follow the alignment of the existing track, with some further sections of new track connecting the launch pads, etc.

Geographical Extent

13.6.54 The Proposed Project occupies an area of approximately 80.8 ha.

Significance of Effect

13.6.55 The combination of the individual judgements of medium sensitivity and substantial magnitude of change on the landscape fabric of the site at the operational stage of the Proposed Project, are considered to result in a major/moderate effect, which in the context of this assessment is considered to be significant. As discussed in the methodology, not all change is adverse and whilst the Proposed Project represents a significant effect upon the landscape resources of the site area, the Proposed Project is considered to represent a positive change to the existing landscape.

Assessment of Effects on Landscape Character and Designations

13.6.56 People's perceptions of the effects of development on landscape character and designated or other relevant landscape areas are closely related to the potential extent and nature of visibility of the development and ancillary infrastructure. An overview of the nature of the visibility of the Proposed Project (the components most likely to be visible) within the LVIA Study Area is therefore provided below.

General Appraisal of Visibility

13.6.57 The potential visual influence of the Proposed Project is closely related to a range of parameters, which include position, elevation, and distance. Due to the position of the Proposed Project on the promontory of land at Lamba Ness, which extends c.2.5 km eastwards into the North Sea between the Blue Jibs peninsula to the north and the headland at the Hill of Clibberswick to the south, the Proposed Project will be seen locally in oblique views to the peninsula. It is considered that within 3 km, where terrain allows, the proposed hangar buildings which rise to c. 14 m, the launch vehicles when temporarily in launch configuration rise up to c.30 m, and the lightning masts which in their operational extended configuration extend to 45 m, will be the most clearly visible elements in the landscape. Although they may not necessarily be intrusive or prominent, these components of the Proposed Project have the potential to be an important and/ or readily noticeable element in the landscape.

13.6.58 The network of local hills and headlands including the Ward of Norwick to the west, 186 m AOD, Ritten Hamar to the north-west, 132 m AOD, Housi Field to the south-west, 122 m AOD, and the Hill of Clibberswick to the south, 160 m AOD, together define a relatively tight visual envelope to the landward side. Visibility to the east is unrestricted and extends across the sea to the apparent horizon.

13.6.59 Local visibility encompasses the settlement at Norwick including the beach and houses close to the Taing and extends along the valley of the Burn of Norwick to include the northern edges of Valsgarth and the former RAF buildings at Saxa Vord. To the north, partial visibility is indicated around the isolated farmstead at Skaw.

13.6.60 Beyond this inner core area of visibility, the Proposed Project will recede in views and be seen as a component in the wider landscape, becoming less distinct, and appearing as distant new elements set in the context of wider views.

13.6.61 To the north-west visibility extends across the upland flank on the eastern side of Saxa Vord, 284 m AOD.

13.6.62 A narrow band of visibility extends to the south-west, to the north of the ridge of land at Valsgarth, across areas of lower lying farmland, encompassing the scattered farmsteads between Ungirsta, Stove, and Quoys. The rising ridge of land to the south west, Crussa Field and Muckle Hoeg, which form the backdrop to the lower lying farmland, define strong containment to views to the south.

13.6.63 Smaller patches of more distant visibility are picked up on the higher ridge of land at Valla Field to the south west, including the uplands at Houllna Gruna 153 m AOD at c.8 km and beyond 10 km the Ward of Houlland, 156 m AOD, and the Byre of Scord, 216 m AOD.

13.6.64 Drawings 13.2.1 - 13.2.2 indicate the zone of theoretical visibility of the Proposed Project within a 15 km radius, based on the maximum potential visibility of the Proposed Project during the launch configuration and the baseline visibility of the Proposed Project when not in operation.

Assessment of Effects upon Landscape, Coastal and Seascape Character Areas (LCTs/CCAs/SCAs)

13.6.65 This section assesses effects upon LCTs/CCAs/SCAs within 15 km of the Proposed Project, as defined in the Scottish Landscape Character Types Map and Descriptions Online (SNH, 2020), the Shetland Coastal Character Assessment, 2016, and Scottish Seascape Areas defined in the NatureScot Report No.103, 2005.

13.6.66 The location of the LCTs/CCAs/SCAs is presented in Drawing 13.1.3. The ZTV of the Proposed Project overlaid with the LCTs/CCAs/SCAs and landscape designations is shown in Drawings 13.2.1 - 13.2.2 to a 15 km limit. The visibility indicated within these Drawings is derived from computer modelling and represents a bare-earth environment, i.e., the modelling does not include built development or localised changes in landform, all of which may screen the development, either in full or in part.

13.6.67 Areas of landward visibility beyond 15 km are very limited, due to the screening effects of landform. It is not considered that the resulting changes to perception of landscape character could give rise to significant effects beyond 15 km, and therefore no further assessment of LCTs/CCAs/SCAs beyond 15 km has been made.

13.6.68 This section describes the operational and in-combination effects resulting from the Proposed Project on the nine landscape, coastal and seascape character areas, as identified in the baseline in Table 13.3, where potentially significant effects may occur, as set out in Tables 13.8 – 13.16.

Table 13.8 Effects on LCT 349 Major Uplands

Location
The landscape character type covers the three main areas of uplands on Unst, at Saxa Vord, Hermaness and Valla Field. The western sector of the Proposed Project located within the LCT. The Hermaness and Valla Field sub-units are located at distances of 4 km and 8.2 km, respectively. The following development, which is within the LCT, currently influences the existing baseline landscape character within the core 15 km LVIA Study Area: ➢ Saxa Vord Radar Station. ➢ Remnants of the former Skaw Radar Station at Inner Skaw – Lamba Ness.
Determination of Landscape Sensitivity
The sensitivity is considered to be **High**. The factors which have contributed to this judgement are as follows: *Value - High* ➢ Hermaness NSA; and, ➢ Part of the Haroldswick and Skaw LLA. *Susceptibility to Change – High to Medium* ➢ Very large-scale landscape; ➢ Long exposed mountain with steep sides; ➢ Low moorland vegetation; and, ➢ Perceptual Qualities: sense of remoteness due to the limited road access and settlement. Open and exposed.
Magnitude of Change
The magnitude of change to the Major Uplands LCT caused by the introduction of the Proposed Project is considered to be **substantial** locally within the site at Inner Skaw and across the eastern flank of the Ward of Norwick, reducing over distance to **slight** on the eastern flank of

Saxa Vord Hill, and negligible within the Hermaness and Valla Field sub units of the LCT. The factors which have contributed to this judgement are as follows:

Size or Scale

The landscapes of the Major Uplands are characterised by expansive views experienced from the exposed summits and flanks. From the eastern flanks of the Ward of Norwick and Saxa Vord, the Proposed Project will be seen below as a new large-scale man-made feature in the landscape, extending across the headland at Lamba Ness. Closer to the site and from the minor road crossing the peninsula the large hangar buildings will appear as angular structures rising above the coastline, though the careful use of colour will assist in reducing their overall bulk.

The prominence of the Proposed Project buildings and infrastructure will vary with light conditions, often receding during reduced light conditions or during haze but, more visible on clear sunny days. The Proposed Project will be viewed in the context of the large-scale, expansive character of the landscape, and will form a visible addition to the landscape in views east, introducing clusters of new development within the context of the existing structures and track of the former Skaw Radar Station, influencing the perception of scale in wider views.

During the short duration of launch cycles at the individual launch pads, the extended lightning masts, the launch vehicle and the supporting strong back will be visible as additional vertical structures. However, within the context of the expansive views from the LCT, these elements will have only a limited additional influence.

The Proposed Project will not alter the openness and expansive nature of views from the uplands and will not substantially affect views between hills within the interior of the island or the visual relationships to the surrounding coastlines. However, some views immediately adjacent to the Proposed Project will be interrupted by the large new vertical structures.

Geographical Extent

The ZTV indicates that there will be visibility from the east facing flanks of the Ward of Norwick, Saxa Vord and Housi Field. There will be small areas of distant influence on the landscape at Houllna Gruna, the Ward of Houlland and the Byre of Scord, marking the higher points along the southern extent of the ridgeline at Valla Field, to the west of Unst, which intersects with a band of distant visibility. There will be no visibility from the western areas of the LCT. Viewpoint 1.3, Drawing 13.3.3 illustrates a local view from the minor road crossing to the west of the site beneath the Ward of Norwick.

Significance of Effect

The combination of the individual judgements of **medium/high** sensitivity and a locally **substantial** magnitude of change from Inner Skaw and the eastern flank of the Ward of Norwick are considered to result in a **major/moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **significant.**

Elsewhere effects on the LCT will give rise to no greater than a **slight** magnitude of change, with a **moderate/minor** and Not significant effect on the perception the landscape.

With distance and the topographic screening by the hills, the influence of the Proposed Project will reduce and will not give rise to any further significant effects on this LCT.

Table 13.9 Effects on LCT 350 Peatland and Moorland

Location
The landscape character type covers areas of rocky heather moorland areas of uplands on Unst, including the Hill of Clibberswick to the south and the ridge line between Muckle Heog and Crussa Field to the south-west, located at distances of 1.2 km and 4.3 km, respectively. The following development, which is within the LCT, currently influences the existing baseline landscape character within the core 15 km LVIA Study Area: ➢ Telecommunications masts at Muckle Heog.
Determination of Landscape Sensitivity
The sensitivity is considered to be **Medium**. The factors which have contributed to this judgement are as follows: *Value - Medium* ➢ Part of the Haroldswick and Skaw LLA. ➢ Part of the Colvadale and Muness LLA. *Susceptibility to Change – Medium* ➢ Medium-scale landscape, contrast between contained internal views and expansive coastal views, with few reference points or features against which to judge scale and perspective; and ➢ Low moorland vegetation.
Magnitude of Change
The magnitude of change to the Peatland and Moorland LCT caused by the introduction of the Proposed Project is considered to be **Moderate** from the north facing flank of the Hill of Clibberswick. There will be Minor influences, on both the north facing flanks of the ridgeline between Muckle Heog and Crussa Field, and from the Keen of Hamar. There will be more distant negligible influences on the Hill of Colvadale. The factors which have contributed to this judgement are as follows: *Size or Scale* These lower hills provide vantage points across the adjacent lowlands. The open simple character of the moorlands contrasting abruptly with the settled coastlines and cultivated lowlands. The introduction of new built form on the peninsula is consistent with the prevailing character and whilst the new built forms will be noticeable, influencing the perception of scale in closer views, they will be experienced within the context of the modified lowlands and against the expansive views across hills and coastlines. The careful use of colour will assist in assimilating the new built form. During the short duration of launch cycles, the extended lightning masts, the launch vehicle and the supporting strong back will have only a limited additional influence.

Geographical Extent

The ZTV indicates that there will be visibility from the north facing flanks of the Hill of Clibberswick at c.1.6 km. There will be areas of visibility from both the north facing flanks of the ridgeline between Muckle Heog and Crussa Field at c.4.5 km, and from the Keen of Hamar at c.5.5 km. There will be more distant negligible influences on the Hill of Colvadale at 8.5 km, to the south of Baltasound, where parts of the hangars will be seen at Inner Skaw. Viewpoint 1.7, Drawing 13.3.1.7 from the Hill of Clibberswick is representative of the typical views within this LCT, at c.2.8 km from the Proposed Project.

Significance of Effect

The combination of the individual judgements of **medium** sensitivity and a locally **moderate** magnitude of change from the Hill of Clibberswick are considered to result in a **moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **not significant**.

Elsewhere effects on the LCT will give rise to no greater than a **slight** magnitude of change, with a **minor** and **not significant** effects on the perception the landscape.

Table 13.10 Effects on LCT 352 Inland Valleys

Location

Within the LVIA Study Area the Inland Valleys landscape character type includes the area of incised land form, located to the south of Burrafirth and encompassing the lands around the Loch of Cliff, and the continuation of the same feature to the south lying to the east of Valla Field.

Determination of Landscape Sensitivity

The sensitivity is considered to be **Medium**. The factors which have contributed to this judgement are as follows:

Value - Medium

- A small part of the Shetland NSA.

Susceptibility to Change – Medium

- Medium scaled landscapes with channelled views, contained by the adjoining uplands; and
- Simple palette of land uses and limited settlement.

Magnitude of Change

The magnitude of change to the Inland Valleys LCT caused by the introduction of the Proposed Project is considered to be **negligible** across the north-east facing flank of Houllna Gruna. The factors which have contributed to this judgement are as follows:

Size or Scale

The hill flanks surrounding the incised valleys reveal extended views to the adjacent lowlands. The simple character of the Inland Valley gives way to diverse settled landscapes of the coastlines and cultivated lowlands beyond. The introduction of new built form on the peninsula will be seen within the diverse landscapes beyond the Inland Valleys in distant views experienced within the context of the modified lowlands. The careful use of colour will assist in assimilating the new built form into the landscape. During the short duration of launch cycles, the extended lightning masts, the launch vehicle and the supporting strong back will have only a limited additional influence. *Geographical Extent* The ZTV indicates that visibility will be limited to the north-east facing flank of the hill slope at Houllna Gruna, over at c.7.5 km.
Significance of Effect
The combination of the individual judgements of **medium** sensitivity and a **negligible** magnitude of change from the north-east facing flank of the hill slope at Houllna Gruna are considered to result in a **minor** local effect on the perception of the landscape, which in the context of this assessment is considered to be **not significant**.

Table 13.11 Effects on LCT 353 Farmed and Settled Lowlands and Coast

Location
Within the LVIA Study Area the Farmed and Settled Lowlands and Coast landscape character type includes the areas farmland at Skaw, on the west of the island of Balta, at Woodwick on the west coast and along coastal edge of Colvadale.
Determination of Landscape Sensitivity
The sensitivity is considered to be of **High - Medium**. The factors which have contributed to this judgement are as follows: *Value - Medium* ➢ Colvadale and Muness, Local Landscape Area ➢ Haroldswick and Skaw, Local Landscape Area *Susceptibility to Change – High-Medium* ➢ This landscape is characterised by a small-scale crofting landscape, strongly associated with the sheltered voes and neighbouring uplands. ➢ The limited modern development and significant historic interest in this landscape, lend a higher degree of sensitivity.
Magnitude of Change
The magnitude of change to the Farmed and Settled Lowlands and Coast LCT caused by the introduction of the Proposed Project is considered to be **moderate** at Skaw reducing to

negligible on the eastern side of the island of Balta. The factors which have contributed to this judgement are as follows: *Size or Scale* The open coastal grazing lands at Skaw are open to views to the headlands to the north and south of the Wick of Skaw which contribute to a diverse setting. The introduction of new built form on the peninsula to the south will be partially seen as new elements beyond the immediate setting of Skaw in views to the wider Wick of Skaw, adding new elements along the bounding skyline to the south. During the short duration of launch cycles, the extended lightning masts, the launch vehicle and the supporting strong back will have additional influence. *Geographical Extent* The ZTV indicates that visibility will extend across the farmland at Skaw. Very small areas of visibility are indicated in across the southern extent of Balta Island.
Significance of Effect
The combination of the individual judgements of **high-medium** sensitivity and a **moderate** magnitude of change from the pastures at Skaw are considered to result in a **major/moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **significant**.

Table 13.12 Effects on LCT 354 Farmed and Settled Voes and Sounds

Location
Within the LVIA Study Area the Farmed and Settled Voes and Sounds landscape character type includes the low-lying settled farmland between Norwick, Haroldswick and Burrafirth, and a further area of settled farmland around Baltasound.
Determination of Landscape Sensitivity
The sensitivity is considered to be of **Medium**. The factors which have contributed to this judgement are as follows: *Value - Medium* ➢ Haroldswick and Skaw, Local Landscape Area ➢ Partially within the Hermaness sub unit of the Shetland NSA however, the area of the LCT within the NSA will experience no intervisibility with the Proposed Project. *Susceptibility to Change – Medium* ➢ This landscape is of a small scale with occasional settlements maintaining the traditional pattern of crofting settlement. There is a strong association with the coastal fringe and significant historic interest. Overall, the LCA has a medium sensitivity to development.
Magnitude of Change

The magnitude of change to the Farmed and Settled Voes and Sounds LCT caused by the introduction of the Proposed Project is considered to be **moderate** at Norwick reducing to Slight at Valsgarth and **negligible** further to the west. The factors which have contributed to this judgement are as follows:

Size or Scale

The open coastal settled farmland at Norwick is open to views to the adjoining headland at Lamba Ness and the Hill of Clibberswick to the south which form part of the wider and diverse backdrop to the LCT. The introduction of new built form on the peninsula to the north will be partially seen as new elements beyond the immediate setting of Norwick, adding additional features along the skyline to the north.

During the short duration of launch cycles, the extended lightning masts, the launch vehicle and the supporting strong back will have additional influence.

Geographical Extent

The ZTV indicates that visibility will extend across the farmland at Norwick, with partial fragmented visibility at Saxa Vord, and then distant visibility to the south-west of the LCT.

No visibility is indicated around Baltasound.

Significance of Effect

The combination of the individual judgements of **medium** sensitivity and a **moderate** magnitude of change from the farmland at Norwick are considered to result in a **moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **not significant**.

Elsewhere effects on the LCT will give rise to no greater than a **slight** magnitude of change, with a **minor** and **not significant** effect on the perception the landscape.

Table 13.13 Effects on LCT 355 Coastal Edge

Location

Within the LVIA Study Area the Coastal Edge landscape character type includes the eastern section of the headland at Lamba Ness, the coastal edge of the Hill of Clibberswick, the north eastern coastline of Unst, The eastern side of Balta Island, the headland at Muness and much of the western coastline of Unst.

The following development, which is within the LCT, currently influences the existing baseline landscape character:

- Remnants of the former Skaw Radar Station at Lamba Ness and Inner Skaw.

Determination of Landscape Sensitivity

The sensitivity is considered to be of **Medium-High** sensitivity, reducing to **Medium** sensitivity around Lamba Ness and Skaw. The factors which have contributed to this judgement are as follows:

Value - Medium

- Haroldswick and Skaw, Local Landscape Area
- Gloup Voe and Bluemull Sound, Local Landscape Area
- Colvadale and Muness, Local Landscape Area
- Hermaness subunit of the Shetland NSA

Susceptibility to Change – Medium

- This landscape has a rugged and irregular landform made up of complex coastal features. There is an absence of settlement and modern development that lends a higher degree of sensitivity. However locally at Skaw and Lamba Ness the presence of disused radar and defence infrastructure it has a locally low to moderate sensitivity to the Proposed Project.

Magnitude of Change

The magnitude of change to the Coastal Edge LCT caused by the introduction of the Proposed Project is considered to be locally **substantial** at Lamba Ness, reducing to **moderate** on the headland to the north at Bluejibs and to **slight** over distance on the northern flank of the Hill of Clibberswick, and to **negligible** in very distant partial views from Muness and Saxa Vord Hill sub units of the LCT. The factors which have contributed to this judgement are as follows:

Size or Scale

The landscapes of the Coastal Edge are heavily influenced by their close association with the surrounding coastline and sea. The large hangar buildings and launch pad infrastructure as well as the wildlife hide will extend across the headland at Lamba Ness, with large scale new structures and infrastructure extending across the coastal grasslands.

The prominence of the Proposed Project buildings and infrastructure will vary with light conditions, often receding during reduced light conditions or during haze but, more visible on clear sunny days. The Proposed Project will be viewed in the context of the large-scale, expansive character of the landscape, and will form a prominent addition to the landscape in views east, introducing clusters of new development within the context of the existing structures and the track of the former Skaw Radar Station, influencing the perception of scale in wider views.

During the short duration of launch cycles at the individual launch pads, the extended lightning masts, the launch vehicle and the supporting strong back will be visible as additional vertical structures.

The Proposed Project will introduce locally significant change to the headland.

Further afield the presence of new structures will be seen to alter the openness and expansive nature of views however, whilst the influence of the Proposed Project is localised, the landscapes closer to the Proposed Project will be altered by influence by the large new structures.

Geographical Extent

The ZTV indicates that there will be direct visibility across Lamba Ness, from the peninsula to the north at Bluejibs and across the north facing flanks of the Hill of Clibberswick.

There will be a distant influence on the eastern side of Balta Island over 6 km to the south and fragmented partial visibility to the lightning masts only from small areas of the headland to the north of Saxa Vord Hill to the west and from Muness to the south. Viewpoint 1.1, Drawing 13.3.1.1 from the peninsula above Bluejibs and the Wick of Skaw to the north is representative of the typical nature of close views within this LCT, at c.1.1 km from the application site. Viewpoint 1.7, Drawing 13.3.1.7 illustrates a more distant view from the Hill of Clibberswick. Viewpoint 1.8, Drawing 13.3.1.8 illustrates the very limited partial views to the lightning masts from the headland to the north of Saxa Vord which lies within the Hermaness sub unit of the Shetland NSA.
Significance of Effect
The combination of the individual judgements of **medium** sensitivity and a locally **substantial** magnitude of change at Lamba Ness are considered to result in a **major/moderate** local effect on the perception of the landscape, which in the context of this assessment is considered to be **significant**. Effects are reduced by distance to **moderate** magnitude of change across the headland to the north of Bluejibs however, the sensitivity is **high**, giving rise to a with a **major/moderate** effect on the perception of landscape character, which in the context of this assessment is considered to be **significant**. Elsewhere effects on the LCT will give rise to no greater than a **slight** magnitude of change, with no greater than a **moderate/minor** and **not significant** effect on the perception the landscape.

Table 13.14 Effects on CCA 20: Skaw

Location
Within the LVIA Study Area the Skaw Coastal Character Area runs from the Noup to Lamba Ness characterised by a rocky exposed coastline with small bays. The landscape is mainly heather moorland and coastal grasses ending in cliffs.
Determination of Landscape Sensitivity
The sensitivity is considered to be of **High** sensitivity, reducing to **Medium** sensitivity around Lamba Ness and Skaw. The factors which have contributed to this judgement are as follows: *Value – Medium-High* ➢ Haroldswick and Skaw, Local Landscape Area ➢ Edge of the Hermaness subunit of the Shetland NSA *Susceptibility to Change – Medium-High* ➢ The Skaw CCA is valued for its scenic qualities. The coast is of high sensitivity to the Proposed Project. However locally at Skaw and Lamba Ness the presence of disused radar and defence infrastructure it has a, locally lower, moderate sensitivity to the Proposed Project.
Magnitude of Change

The magnitude of change to the Skaw Coastal Character Area caused by the introduction of the Proposed Project is considered to be locally **Substantial** at Lamba Ness, reducing to **Moderate** on the headland to the north at Bluejibs. The factors which have contributed to this judgement are as follows:

Size or Scale

The Proposed Project will be seen as a new large-scale man-made development, experienced in the context of the expansive coastal views, forming prominent elements in local views. The large hangar buildings and launch pad infrastructure will extend across the headland at Lamba Ness, with large scale new structures, infrastructure extending across the coastal grasslands and the proposed wildlife hide at the end of the peninsula.

The new development will be seen within the context of the existing structures and the track of the former Skaw Radar Station, influencing the perception of scale in wider views.

During the short duration of launch cycles at the individual launch pads, the extended lightning masts, the launch vehicle and the supporting strong back will be visible as additional vertical structures.

Further afield the presence of new structures will be seen to alter the openness and expansive nature of views however, whilst the influence of the Proposed Project is localised, the landscapes closer to the Proposed Project will be altered by the influence of the large new structures.

Geographical Extent

The ZTV indicates that there will be direct visibility across Lamba Ness and from the peninsula to the north at Bluejibs.

Viewpoint 1.1, Drawing 13.3.1.1 from the peninsula above Bluejibs and the Wick of Skaw to the north, at from Viewpoint 1.2, Drawing 13.3.1.2 at Skaw Beach to the north west, are representative of the typical nature of close views within this CCA, at c.1.1 km and 1.2 km from the application site respectively.

Significance of Effect

The combination of the individual judgements of **medium** sensitivity and a locally **substantial** magnitude of change at Lamba Ness are considered to result in a **major/moderate** local effect on the perception of the coastal character, which in the context of this assessment is considered to be **significant**.

Effects are reduced by distance to **moderate** magnitude of change across the headland to the north of Bluejibs however, the sensitivity is **high**, giving rise to a with a **major/moderate** effect on the perception of the coastal character, which in the context of this assessment is considered to be **significant**.

Elsewhere effects on the LCT will give rise to no greater than a **slight** magnitude of change, with no greater than a **moderate** and **not significant** effect on the perception the landscape.

Table 13.15 Effects on CCA 16: East Unst

Location
Within the LVIA Study Area the East Unst Coastal Character Area runs from Lamba Ness in the north to Mu Ness in the south.
Determination of Landscape Sensitivity
The sensitivity is considered to be of **high** sensitivity. The factors which have contributed to this judgement are as follows: *Value – Medium* ➢ Haroldswick and Skaw, Local Landscape Area *Susceptibility to Change – High* ➢ Much of the East Unst CCA is devoid of modern development. The coast is of high sensitivity to the Proposed Project.
Magnitude of Change
The magnitude of change to the East Unst Coastal Character Area caused by the introduction of the Proposed Project is considered to be locally **Moderate** on the beaches at Nor Wick around the Taing and the coastline at the northern edge of the Hill of Clibberswick. The factors which have contributed to this judgement are as follows: *Size or Scale* The Proposed Project will be seen as a new large-scale man-made development, experienced in the context of the expansive coastal views, introducing new structures along the headland at Lamba Ness. The large hangar buildings and launch pad infrastructure and the proposed wildlife hide will be partially visible across the headland at Lamba Ness, influencing the perception of scale in wider views. During the short duration of launch cycles at the individual launch pads, the extended lightning masts, the launch vehicle and the supporting strong back will be visible as additional vertical structures. Further afield the presence of new structures will be seen to alter the openness and expansive nature of views however, whilst the influence of the Proposed Project is localised, the landscapes closer to the Proposed Project will be altered by the influence of the large new structures. *Geographical Extent* The ZTV indicates that there will be indirect visibility across the beaches at the Taing and along the coastal edge to the north of the Hill of Clibberswick. More distant visibility is indicated on the northern sector of Balta Island over c.6 km.

Viewpoint 1.4, Drawing 13.3.1.4 from The Taing at Nor Wick is representative of the typical nature of views within this CCA, at c.800 m from the application site.
Significance of Effect
The combination of the individual judgements of **high** sensitivity and a locally **moderate** magnitude of change at The Taing and along the coastline north of the Hill of Clibberswick are considered to result in a **major/moderate** local effect on the perception of the coastal character, which in the context of this assessment is considered to be **significant**. Elsewhere effects on the LCT will give rise to no greater than a **negligible** magnitude of change, with no greater than a **minor** and **not significant** effects on the perception the landscape.

Table 13.16 Effects on Seascape Character Type 13 D: Islands, Sounds and Voes

Location
Within the LVIA Study Area the Seascape Character Type 13 D: Islands, Sounds and Voes includes the areas of the North Sea adjoining the farmed and settled coastal lowlands to the east of Unst where a deeply indented coastline creates sounds and voes with fragmented islands. This sub type generally has an insignificant low, hard coastal edge, often appearing smooth and 'submerged'. Voes and sounds form sheltered narrow channels of coastal waters with open, gently sloping hinterland of pasture, rough grazing and scattered crofting. Views over small islands to open sea are often a feature.
Determination of Landscape Sensitivity
The sensitivity is considered to be of High sensitivity. The factors which have contributed to this judgement are as follows: *Value – Medium* ➢ Haroldswick and Skaw, Local Landscape Area *Susceptibility to Change – High* ➢ Development may affect the intricate land/sea relationship and views of outlying islands and the appreciation of the vertical scale of high cliffs where these are present. The perception of remoteness and wildland qualities of some coastal areas and the highly natural character of the outlying islands may also be affected by development.
Magnitude of Change
The magnitude of change to the Seascape Character Type 13 D: Islands, Sounds and Voes caused by the introduction of the Proposed Project is considered to be locally **Moderate** from the seas around the Wick of Skaw, beyond Lamba Ness and from Nor Wick. The factors which have contributed to this judgement are as follows: *Size or Scale*

Whilst there be few receptors the Proposed Project will be seen as a new large-scale man-made development in wider seascape, experienced in the context of the expansive coastal views, introducing new structures along the headland at Lamba Ness. The main visible structures will be the large hangar buildings on the headland, influencing the perception of scale in wider views. During the short duration of launch cycles at the individual launch pads, the extended lightning masts, the launch vehicle and the supporting strong back will be visible as additional vertical structures. Further afield the presence of new structures will diminish with distance, seen against the open and expansive nature of views. The strong influence of the Proposed Project is localised, limited to the closer inshore seascape which will be altered by the influence of the large new structures. However, the given the strong tidal movements around the headlands and the presence of overfalls which together influence a considerable area of the surrounding sea, for long periods, inshore receptors are limited to periods of rare calmer and benign sea conditions. *Geographical Extent* The ZTV indicates that there will be the potential for extensive visibility from the sea.
Significance of Effect
The combination of the individual judgements of **high** sensitivity and a locally **moderate** magnitude of change to the inshore waters within the Wick of Skaw, around the headland at Lamba Ness and within Nor Wick, are considered to result in the potential for **major/moderate** local effect on the perception of the seascape, which in the context of this assessment is considered to be **significant**. Effects on seascape will reduce with distance and will give rise to no greater than **slight** magnitudes of change, with **moderate/minor** and **not significant** effects on the perception the seascape.

Summary of Effects on Landscape, Coastal and Seascape Character Areas

Table 13.17 lists and summarises effects on Landscape, Coastal and Seascape Character Areas assessed above. It sets out their sensitivity to change, the magnitude of change that will arise as a result of the Proposed Project, and the level of resultant effects and their significance.

Table 13.17 Summary of Effects on Landscape, Coastal, and Seascape Character Areas

Landscape/ Coastal/ Seascape Character Areas	Overall Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
349 Major Uplands	High	Locally Substantial Elsewhere Slight	Locally Major/Moderate Elsewhere Moderate / Minor	Locally significant Elsewhere Not significant
350 Peatland	Medium	Locally Moderate Elsewhere Slight	Locally Moderate Elsewhere Minor	Not significant

Landscape/ Coastal/ Seascape Character Areas	Overall Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
and Moorland				
352 Inland Valleys	Medium	Negligible	Minor	Not significant
353 Farmed and Settled Lowlands and Coast	High Medium	Moderate	Major/Moderate	Significant
354 Farmed and Settled Voes and Sounds	Medium	Locally Moderate Elsewhere Slight	Locally Moderate Elsewhere Minor	Locally significant Elsewhere Not significant
355 Coastal Edge	High Medium	Locally Substantial (Lamba Ness) Moderate (Blue Jibs) Elsewhere Slight	Major/Moderate (Lamba Ness) Major/Moderate (Blue Jibs) Elsewhere Moderate/Minor	Locally significant (Lamba Ness and Blue Jibs) Elsewhere Not significant
CCA 16, East Unst	High	Locally Substantial (Lamba Ness) Moderate (Blue Jibs) Elsewhere Negligible	Major/Moderate (Lamba Ness) Major/Moderate (Blue Jibs) Elsewhere Minor	Locally significant (Lamba Ness and Blue Jibs) Elsewhere Not significant
CCA 20, Skaw	High	Locally Moderate Elsewhere Negligible	Locally Moderate Elsewhere Minor	Not significant
Seascape Character Type 13 D: Islands, Sounds and Voes	High	Locally Moderate Elsewhere Slight	Locally Major/Moderate Elsewhere Moderate/Minor	Locally significant Elsewhere Not significant

Assessment of Effects on Designated Landscapes

13.6.69 This section considers the implication of the Proposed Project on designated landscapes falling within the LVIA Study Area. The designated landscapes listed below have been considered in more detail, following the preliminary analysis of visibility of the Proposed Project, with some designated landscapes having been scoped out of the assessment because of the absence of visibility (see Table 13.4).

- Hermaness sub-unit of the Shetland NSA

- Haroldswick and Skaw, LLA

13.6.70 The analysis cross references to the assessment of landscape, coastal and seascape character, the assessment of visual effects, the assessment of in-combination effects, and has given regard to the special qualities and features for which each receptor has been designated. Designated landscapes are shown on Drawings 13.2.1 – 13.2.2 overlaid with the ZTVs of the respective components of the Proposed Project to a 15 km radius.

Shetland NSA

13.6.71 The Shetland NSA includes seven designated areas. Of these a very small area of the Hermaness sub-unit falls into the zone of theoretical visibility within 15 km of the Proposed Project. The overall special qualities of the Shetland NSA are described within The Special Qualities of the National Scenic Areas, NatureScot commissioned report, 2010, as:

- The stunning variety of the extensive coastline
- Coastal views both close and distant
- Coastal settlement and fertility within a large hinterland of unsettled moorland and coast
- The hidden coasts
- The effects and co-existence of wind and shelter
- A sense of remoteness, solitude and tranquillity
- The notable and memorable coastal stacks, promontories and cliffs
- The distinctive cultural landmarks
- Northern light

13.6.72 Some special qualities are generic to all the identified NSA areas, others are specific to each area within the NSA. For the Hermaness sub-unit the feeling of being at the northern limits of the British Isles is marked, and within the Shetland archipelago these areas have a greater degree of remoteness.

13.6.73 The Hermaness sub-unit of the Shetland NSA includes the following specific special qualities, which are described within the NatureScot report:

- "At Hermaness on Unst, the coastal topography varies from the 175 m high cliffs at the Neap, to the sandy beach and machair at the head of the narrow Burrafirth.
- Cultural landmarks include the western edge of the Hermaness area which contains the northerly military installations in the British Isles at Saxa Vord."

13.6.74 Drawings 13.2.1 – 13.2.2 illustrate the extent of theoretical visibility to the Proposed Project, indicating two very limited areas of visibility, firstly on the summit of Saxa Vord in the context of the existing radar dome over a distance of 2.5 km, and secondly limited visibility to lightning masts only from a very small area of the headland to the north of Saxa Vord Hill, in the context of dismantled radar masts over a distance of 3.3 km. Viewpoint 1.8, Headland to the north of Saxa Vord radar station, Drawing 13.3.1.8 illustrates the nature of views from the headland within the NSA.

13.6.75 The sub-unit of the NSA includes parts of LCT 349 Major Uplands, LCT 355 Coastal Edge, LCT 354 Farmed and Settled Voes and Sounds, CCA 19 Hermaness, and CCA 13 Burrafirth. The assessment of effects on LCTs and CCAs finds no significant effects on these areas within the area of the NSA, and no potential significant additional combined effects. This is due to the screening effects of topography. A Minor (not significant) effect was found to affect receptors at Viewpoint 1.8, Headland to the north of Saxa Vord Radar Station, Drawing 13.3.1.8.

13.6.76 A separate Special Landscape Qualities (SLQ) Assessment on the Special Qualities of National Scenic Areas based on the new draft NatureScot Guidance for Assessing the Effects on Special Landscape Qualities Working Draft November 2018, is set out in Appendix 13.5.

13.6.77 In summary, the special qualities of the Special Landscape Qualities of the Hermaness sub area of the Shetland NSA will not be at risk or compromised by the Proposed Project and the overall integrity and objectives of the Shetland NSA will be maintained.

Local Landscape Areas

13.6.78 Designation statements for Local Landscape Areas (LLAs) in Shetland are set out in the Shetland Islands Council Report, Local Landscape Designations Review (LLDR), 2011.

13.6.79 The Proposed Project lies within the Haroldswick and Skaw LLA which comprises the hills and headlands between Harold's Wick in the south and Burra Firth to the north-west, including the Hill of Clibberswick and Saxa Vord. The LLA has been identified with the following Key characteristics:

- *"Part of the most northerly area of Shetland and Britain;*
- *Highly visible military defence infrastructure, including active and disused elements;*
- *Rugged, exposed northern coast, with sheltered sandy bays;*
- *Rich geology visible at the surface;*
- *Actively settled area undergoing redevelopment as former military uses decline and new uses are found."*

13.6.80 The LLA comprises an extensive area of hills and headlands and the north-eastern extent of Unst. Drawings 13.2.1 – 13.2.2 illustrate the extent of theoretical visibility to the Proposed Project, indicating a swathe of visibility across the eastern flank of Saxa Vord Hill and the Ward of Norwick, the north flank of the Hill of Clibberswick, at Skaw to the north, and across Inner Skaw and the headland at Lamba Ness.

13.6.81 The LLA includes parts of LCT 349 Major Uplands, LCT 350 Peatland and Moorland, LCT 353 Farmed and Settled Lowlands and Coast, LCT 354 Farmed and Settled Voes and Sounds, and LCT 355 Coastal Edge, all of which experience areas of visual influence of the Proposed Project. The assessment of effects on LCTs found locally significant effects on each of the LCTs (excluding LCT 350) within the area of the LLA, and no potential significant in-combination effects. This is due to the influence of the Proposed Project which will be seen as a new relatively large-scale development across the headland between Inner Skaw and Lamba Ness. Whilst the Proposed Project will be seen in the context of the major uplands and expansive coastal views, locally the scale of the new built form will have an influence on landscape scale, forming large contrasting elements, seen against coastal views or the prevailing moorland backdrop.

13.6.82 The key characteristics and integrity of the LLA will be locally altered by the Proposed Project across the headland between Inner Skaw and Lamba Ness, with a reduction in the scenic qualities of the LLA.

13.7 Assessment of Effects on the Visual Resource

13.7.1 The following sections provide an assessment of the visual effects that will likely arise from the Proposed Project. The following assessment addresses effects on the visual amenity of people, through assessing:

- effects on settlements;
- effects on key transport routes; and,
- effects on viewpoints.

Assessment of Effects on Settlements

13.7.2 The following section provides an assessment of the predicted effects on the visual amenity that will be experienced by residents of principal settlements within the LVIA Study Area. The assessment has been undertaken through field survey and the analysis of mapping ZTV and photomontage views, in order to confirm the likely nature of visibility.

13.7.3 In accordance with the criteria outlined in the detailed methodology in Appendix 13.1, residential receptors, within settlements in the LVIA Study Area, have a high susceptibility to change as views are experienced regularly for prolonged periods, and are generally considered to have a high sensitivity overall to the Proposed Project.

13.7.4 An indication of the predicted extents of visibility for the Proposed Project across the settlements is provided within the visibility mapping in Drawings 13.2.1 to 13.2.2. All ZTV drawings are based on bare-ground conditions, in accordance with current good practice as indicated in GLVIA 3. For those settlements where the ZTV indicates theoretical visibility, buildings and, to a small degree land form, are likely to provide a degree of containment between receptors and the Proposed Project. Buildings and localised topography do not register on the ZTV and, therefore, views to the Proposed Project will tend to be more restricted and more intermittent than the ZTV indicates.

13.7.5 The settlements in the LVIA Study Area with potential views of the Proposed Project, as identified in Table 13.5, are assessed below.

Table 13.18 Effects on settlement at Booths/Houlanbrindy

Location
The cluster of settlement at Booths/Houlanbrindy, c.660 m to the south-west of the site, lies sheltered to the rear of Nor Wick and beneath the Ward of Norwick. The properties face east across Nor Wick which is framed by the cliffs of the Lamba Ness headland to the north and the Hill of Clibberswick to the south. The following development currently weakly influences the existing baseline: ➢ Redundant derelict wartime buildings on Lamba Ness.
Determination of Visual Sensitivity
The settlement at Booths/Houlanbrindy is of High sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive coastal views; ➢ Orientation of buildings to the east; ➢ Influence of existing development at the former Skaw Radar Station.
Magnitude of Change
The magnitude of change to the settlement at Booths/Houlanbrindy caused by the introduction of the Proposed Project is considered to be **Moderate**. The factors which have contributed to this judgement are as follows: *Size or Scale*

Elements of the Proposed Project including: partial view to the roofline of the hangars; site fencing; partial view to the southern radome of the tracking station; the lightning masts; launch vehicles on pad 3, will be seen as a new man-made development appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views. During the short duration of launch cycles, the extended lightning masts, the launch vehicle and the supporting strong back will be visible as additional vertical structures. *Geographical Extent* The ZTV indicates that there will be the potential for partial visibility away from the primary orientation of the views from the properties.
Significance of Effect
The combination of the individual judgements of **high** sensitivity and a locally **moderate** magnitude of change are considered to result in the potential for **major/moderate** local effect on the settlement at Booths/Houlanbrindy, which in the context of this assessment is considered to be **significant**.

Table 13.19 Effects on settlement at Norwick/Kirkaton

Location
The cluster of settlement at Norwick/Kirkaton, c.1.2 km to the south-west of the site, lies sheltered to the rear of Nor Wick and beneath the Ward of Norwick. The properties face east across Nor Wick which is framed by the cliffs of the Lamba Ness headland to the north and the Hill of Clibberswick to the south. The following development currently weakly influences the existing baseline: ➢ Redundant derelict wartime buildings on Lamba Ness.
Determination of Visual Sensitivity
The settlement at Norwick/Kirkaton is of **high** sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive coastal views; ➢ Orientation of buildings to the east; ➢ Influence of existing development at the former Skaw Radar Station.
Magnitude of Change

The magnitude of change to the settlement at Norwick/Kirkaton caused by the introduction of the Proposed Project is considered to be **moderate**. The factors which have contributed to this judgement are as follows: *Size or Scale* Elements of the Proposed Project including partial visibility to the gate house and hangars; boundary fencing; the southern radomes of the tracking station; the Integration/TEL Building; launch vehicles and lightning masts, will be seen as a new man-made development appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views. During the short duration of launch cycles at each of the launch pads, the extended lightning masts, the launch vehicles and the supporting strong backs will be visible as additional vertical structures. *Geographical Extent* The ZTV indicates that there will be the potential for partial visibility from the properties.
Significance of Effect
The combination of the individual judgements of **high** sensitivity and a **moderate** magnitude of change are considered to result in the potential for **major/moderate** effects on the settlement at Norwick/Kirkaton, which in the context of this assessment is considered to be **significant**.

Table 13.20 Effects on settlement at Valsgarth/Saxa Vord

Location
The cluster of settlement at Valsgarth/Saxa Vord, c.2.3 km to the south-west of the site, lies on elevated ground to the south of Northdale. The north-eastern properties have a relatively open aspect towards Norwick and the coastline around Nor Wick beyond. The following development currently influences the existing baseline: ➢ Redundant derelict wartime structures between Inner Skaw and Lamba Ness.
Determination of Visual Sensitivity
The settlement at Valsgarth/Saxa Vord is of **high** sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive views, contrasting with truncated views between housing; ➢ Orientation of the north eastern edge towards Norwick; ➢ Influence of existing development at the former Skaw Radar Station.

Magnitude of Change
The magnitude of change to the settlement at Valsgarth/Saxa Vord caused by the introduction of the Proposed Project is considered to be **moderate**. The factors which have contributed to this judgement are as follows: *Size or Scale* Elements of the Proposed Project including partial visibility to the gate house and hangars; boundary fencing; the southern radomes of the tracking station; the integration/TEL building, launch vehicles and lightning masts, will be seen as a new man-made development appearing in more distant views above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views. During the short duration of launch cycles at each of the launch pads, the extended lightning masts, the launch vehicles and the supporting strong backs will be visible as additional vertical structures. *Geographical Extent* The ZTV indicates that there will be the potential for partial visibility from the north-eastern edge of the settlement which has a sight line to the Proposed Project.
Significance of Effect
The combination of the individual judgements of **high** sensitivity and a **moderate** magnitude of change are considered to result in the potential for **major/moderate** effects on the settlement at Valsgarth/Saxa Vord, which in the context of this assessment is considered to be **significant**.

Table 13.21 Effects on settlement at Clibberswick

Location
The cluster of settlement at Clibberswick, c.1.05 km to the south east of the site, lies within open farmland to the south of Saxa Vord. The properties have a relatively open aspect towards Valsgarth/Saxa Vord seen beneath the Ward of Norwick.
Determination of Visual Sensitivity
The settlement at Clibberswick is of **high** sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive views across the open farmland and coastline.
Magnitude of Change
The Proposed Project has no influence on the settlement at Clibberswick.

Potential for in-Combination Effects
No combined effects are predicted.
Significance of Effect
No Effect.

Table 13.21 Effects on settlement at Haroldswick

Location
The cluster of settlement at Haroldswick, c.3.2 km to the south-west, lies within farmland at the head of Harold's Wick. The southern edge of the settlement extends along the foreshore and is visually screened from the Proposed Project. The more dispersed properties to the north are set on slightly elevated ground with more open views across the farmland to the north.
Determination of Visual Sensitivity
The settlement at Haroldswick is of High sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Expansive views across the open farmland and coastline.
Magnitude of Change
The Proposed Project has no influence on the settlement at Haroldswick. *Size or Scale* Changes to the views from Haroldswick will be negligible. *Geographical Extent* There will be the potential for partial visibility from the properties at the northern edge of Haroldswick.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effect
No effect.

Table 13.22 Effects on settlement at Ungirsta/Stove

Location
Ungirsta and Stove encompass the dispersed crofting settlement to the north and west of Haroldswick, set across the farmed lowlands between the ridge at Crussa Field to the south and Housi Field to the north, c.3.05 km to the south west of the Proposed Project. The properties are dispersed and experience oblique views across the surrounding open farmland against the backdrop of low rounded hills.
Determination of Visual Sensitivity
The properties at Ungirsta and Stove are of **high** sensitivity. The factors which have contributed to this judgement are as follows: ***Value*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ***Susceptibility to Change*** *– Medium/High* ➢ Views across the open farmland and to the surrounding hills.
Magnitude of Change
The Proposed Project has no influence on the scattered settlement at Ungirsta and Stove. *Size or Scale* The changes to the views from Ungirsta and Stove will be negligible. *Geographical Extent* There will be the potential for partial visibility from the properties at the northern edge of Ungirsta and Stove.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effect
No Effect.

Summary of Effects on Settlements

13.7.6 Table 13.23 lists and summarises effects on the settlements assessed above. It sets out their sensitivity to change, the magnitude of change that will arise as a result of the Proposed Project, and the level of resultant effects and their significance.

Table 13.23 Summary of Effects on Settlements

Settlement	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
Booths/ Houlanbrindy	High	Moderate	Major/Moderate	significant
Norwick/ Kirkaton	High	Moderate	Major/Moderate	significant

Settlement	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
Valsgarth/ Saxa Vord	High	Moderate	Major/Moderate	significant
Haroldswick	High	Negligible.	No effect	Not significant
Ungirsta/ Stove	High	Negligible.	No effect	Not significant

Assessment of Effects on Routes

13.7.7 The following section provides an assessment of the predicted effects of the Proposed Project on visual amenity that will be experienced by travellers using vehicular and non-vehicular route corridors within the LVIA Study Area, including roads and designated cycle routes. The assessment has been undertaken through field survey and the analysis of mapping ZTV and wireframe views, in order to confirm the likely nature of visibility.

13.7.8 In accordance with the criteria outlined in the detailed methodology in Appendix 13.1, the sensitivity of receptors from cycle routes is generally considered to be high. Receptors using road routes (i.e., motorised vehicle users of cars/ motorbikes/ buses) are considered to range from low or low to medium (e.g., for trunk and main roads) through to medium (for B-roads, minor roads etc.) sensitivity, although vehicle users of routes promoted or noted for scenic value may be of medium to high sensitivity. There may also be value attached to specific views along the routes or particular stretches where they pass through or overlook designated landscapes.

13.7.9 An indication of the predicted extents of visibility route corridors is provided within the visibility mapping in Drawings 13.2.1 to 13.2.2.

13.7.10 The principal effects on these routes with potential views of the Proposed Project, as identified in Table 13.6, are assessed below.

Table 13.24 Operational Effects on A968/National Cycle Route 1

Route Description
The A968/NCR1 connects through the LVIA Study Area between Gunnister in mid-Unst at c.15 km through to Haroldswick within 5 km of the Proposed Project. The following development currently weakly influences the existing baseline: ➢ Telecommunications relay building on the Hill of Caldback. ➢ Telecommunications mast on Little Hoeg. ➢ Radar radome on Saxa Vord Hill.
Determination of Visual Sensitivity
People in motorised vehicles using the route are considered to be of **medium** sensitivity to changes resulting from the Proposed Project. Cyclists using the route are considered to be of **high** sensitivity to changes resulting from the Proposed Project. The factors which have contributed to this judgement are as follows: **Value** – Medium

Susceptibility to Change – Medium/High ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor; ➢ Cyclists are likely to be using the route for recreation and tourism purposes and will be aware of views to the surrounding landscape; ➢ Relative simplicity of landform with smooth and rounded pastures and expansive views.
Magnitude of Change
From a short c.600 m section of the route as it passes across the col to the east Little Hoeg, there will be a locally **Slight** magnitude of change as the Proposed Project is partially seen on the horizon above Clibberswick. *Size or Scale* The buildings at the western extent of the site will be partially visible to their rooflines, as a noticeable new element on the horizon in views to the north seen in the distance over c.4.5 km. The new man-made development will be seen to contrast slightly with the scale of the existing development and with the soft hues of the moorland hills. *Geographical Extent* The ZTV indicates that there will be the potential for partial visibility over a short c.600m section of the route.
Potential for In-Combination Effects
There will be a locally **minor not significant** combined effect on a very short section of the route corridor over the short term.

Significance of Effect

Section of A968 / NCR 1	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
600m section of the route, east of Little Hoeg	Motorists – Medium Cyclists - High	Slight	Moderate/minor to Motorists and Moderate to Cyclists	**Not significant**

Table 13.25 Operational Effects on B9086

Route Description
The B9086 connects between Burrafirth and Haroldswick through the study area at c.3.9 km from the Proposed Project and c.1.3k m from the LCC/RCC building. The following development currently weakly influences the existing baseline: ➢ Telecommunications mast on Little Hoeg. ➢ Radar radome on Saxa Vord Hill.
Determination of Visual Sensitivity

People in motorised vehicles using the route are considered to be of **Medium** sensitivity to changes resulting from the Proposed Project. Cyclists using the route are considered to be of **High** sensitivity to changes resulting from the Proposed Project. The factors which have contributed to this judgement are as follows:

Value – Medium

Susceptibility to Change – Medium/High

- Motorists travelling through or past the landscape on roads will focus on the route corridor;
- Cyclists are likely to be using the route for recreation and tourism purposes and will be aware of views to the surrounding landscape;
- Relative simplicity of landform with smooth and rounded pastures and expansive views.

Magnitude of Change

Proposed Project

From a short c.500 m section of the route, between the minor road leading to Ungirsta and the cross road junction at Lower House, there will be a locally **Slight** magnitude of change as the Proposed Project is partially seen on the distant horizon above Norwick.

Size or Scale

The buildings at the western extent of the site will be partially visible to their rooflines, as a distant new element on the horizon in views to the north east, over c.3.9 km.

Geographical Extent

The ZTV indicates that there will be the potential for partial visibility over a short c.500 m section of the route.

Potential for in-Combination Effects

There will be a locally **minor not significant** combined effect on a very short section of the route corridor over the short term.

Significance of Effect

Section of B9086	Sensitivity to Change	Magnitude of Change	Level of Effect	Significance
1.2 km section of the route west of Haroldswick	Motorists – Medium Cyclists - High	Slight	Moderate/Minor to Motorists and Moderate to Cyclists	**Not significant**

Table 13.26 Operational Effects on B9087

Route Description

The B9087 connects between Haroldswick and Norwick through the LVIA Study Area with areas of closest visibility over c. 1.3 km from the Proposed Project.

The following development currently influences the existing baseline:

- Telecommunications mast on Little Hoeg.
- Radar radome on Saxa Vord Hill.
- The former RAF base at Saxa Vord.

Determination of Visual Sensitivity

People in motorised vehicles using the route are considered to be of **medium** sensitivity to changes resulting from the Proposed Project. Cyclists using the route are considered to be of **High** sensitivity to changes resulting from the Proposed Project. The factors which have contributed to this judgement are as follows:

Value – Medium

Susceptibility to Change – Medium/High

- Motorists travelling through or past the landscape on roads will focus on the route corridor;
- Cyclists are likely to be using the route for recreation and tourism purposes and will be aware of views to the surrounding landscape;
- Relative simplicity of landform with smooth and rounded pastures and expansive views.

Magnitude of Change

There will be increasing visibility between Saxa Vord and Norwick, with a locally **Moderate** magnitude of change as the Proposed Project is seen on the peninsula between Inner Skaw and Lamba Ness.

Size or Scale

Elements of the Proposed Project including: partial visibility to the gate house and hangars; boundary fencing; the southern radomes of the tracking station; the integration hangar/TEL building; launch vehicles and lightning masts, will be seen as a new man-made development appearing above the cliffs to the north of Nor Wick, influencing the perception of scale in wider views.

During the short duration of launch cycles at each of the launch pads, the extended lightning masts, the launch vehicles and the supporting strong backs will be visible as additional vertical structures.

Geographical Extent

The ZTV indicates that there will be the potential for partial visibility over a c.1.2 km section of the route.

Potential for In-Combination Effects

There will be a locally **minor not significant** combined effect on a very short section of the route corridor over the short term.

Significance of Effect				
Section of B9087	**Sensitivity to Change**	**Magnitude of Change**	**Level of Effect**	**Significance**
1.2 km section of the route west between Saxa Vord/ Valsgarth and Norwick.	Motorists – Medium Cyclists - High	Moderate	Moderate to Motorists and Major/Moderate to Cyclists	**Not significant/ significant**

Assessment of Effects at Viewpoints

13.7.11 The viewpoint assessment has been carried out to identify and evaluate the effects on visual amenity arising from the Proposed Project at specific representative locations in the study area. The selection of viewpoints is discussed at paragraph 13.5.60.

13.7.12 The predicted views from each of the 15 viewpoint locations are illustrated using photomontages in Drawings 13.3.1.1 to 13.3.1.10 in respect of the Proposed Project and, as relevant, and in Drawings 13.3.2.1 – 13.3.2.5 for the LRCC. The visualisations are accurate graphic representations in terms of the positioning, spatial distribution and size of the Proposed Project.

13.7.13 For the purposes of assessing the effects on visual amenity, the sensitivity of the receptors is as defined in Appendix 13.1.

13.7.14 The following detailed analysis of the 15 viewpoints include a description of the existing and predicted view, an assignment of receptor sensitivity (including confirmation of receptor susceptibility and the value applied to the viewpoint), an analysis of the magnitude of change, and an assessment of the level of predicted effects on visual amenity, and a determination of their significance. The supporting Drawings include existing photographic view alongside a photomontage visualisation of the Proposed Project. These visualisations have been prepared in adherence to the principles presented in the Landscape Institute's Technical Guidance Note TGN 06/19 Visual Representation of Development Proposals, as described in Appendix 13.1.

Duration and Reversibility of the Visual Effects

13.7.15 The magnitude of changes that will be experienced by visual receptors as a result of the Proposed Project relates in part to the duration of effects and their permanence/ reversibility. For the purposes of this assessment the effects are assumed to be permanent.

13.7.16 As the duration and reversibility of the effects of the Proposed Project will be common to all visual receptors, they have been implicitly considered with regard to the likely magnitude of change in all views but are not repeated with regard to each viewpoint to avoid repetition.

Proposed Project Viewpoints, Viewpoints 1.1 – 1.10

Table 13.27 Effects at Viewpoint 1.1, Bluejibs above the Wick of Skaw

Viewpoint 1.1, Bluejibs above the Wick of Skaw Drawing 13.3.1.1 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 1.1 km to the south

Viewpoint 1.1, Bluejibs above the Wick of Skaw Drawing 13.3.1.1 existing view and a panoramic photomontage of the Proposed Project.	
LCT/CCA and Designations	LCT355. Coastal Edge / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors – High
Theoretical visibility	Proposed Project only

Location and Rationale for Selection

The viewpoint is located on the north-eastern peninsula of Unst, looking south across the Wick of Skaw. The headland at the northern tip of British Isles is a popular location for visitors and for walkers accessing the northern coastline of Unst.

The following development currently influences the existing baseline:

- The derelict buildings and infrastructure associated with the former Skaw Radar Station both across the foreground of the headland and also as seen in more distant views across the peninsula to the south at Lamba Ness.
- The maritime navigation beacon on the Holm of Skaw.
- The radar radome on Saxa Vord hill to the west.

Description of Existing View

The existing view looks south across the Wick of Skaw to the peninsula between Inner Skaw and Lamba Ness. The Sand of Inner Skaw is seen to the right of the image, with the distant high cliffs of the Hill of Clibberswick beyond. Flowering cotton grass carpets the foreground of the view. The viewpoint, at 30 m AOD, provides an attractive vantage point for views to the surrounding coastlines. The intense tidal races around this headland with standing waves and overfalls at certain states of tides add local interest. Features of the former Radar Station on Lamba Ness are noticeable including the following: the earth banked building of the former receiver building at the end of Lamba Ness; the earth banked power house building towards the centre of the peninsula; and the further concrete power house block seen on the crest of the peninsula above the Sand of Inner Skaw.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and visitors who access the headland for recreation and therefore more susceptible to changes in the view:

Value *– Medium*

Susceptibility to Change *– High*

- Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- Elemental coastal scenery with expansive views.

Viewpoint 1.1, Bluejibs above the Wick of Skaw Drawing 13.3.1.1 existing view and a panoramic photomontage of the Proposed Project. Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **substantial**. ***Size or Scale*** The Proposed Project will be seen extending across the headland between Inner Skaw and Lamba Ness. The new built form will appear on the horizon line to the south, adding new noticeable features along the peninsula. The radomes of the tracking station will be seen against the backdrop of coastal hills and cliffs beyond. The lightning masts will be seen as tall vertical elements punctuating the skyline. Launch pad three is illustrated in its extended pre-launch condition with the launch vehicle and strongback erected and the lightning masts extended in full. The wildlife hide will be seen as new small-scale structure at the eastern edge of the Lamba Ness peninsula. Launch pads one and two are shown in their retracted state. The TEL hangar is seen between launch pads one and two, breaking the horizon line. The base infrastructure around launch pad one is also seen on top of the peninsula. ***Geographical Extent*** The Proposed Project across the Proposed Project will be seen over a c.50° angle of view. Views of this nature will be experienced across the southern edge of the headland above the Wick of Skaw.
Potential for In -Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **substantial** magnitude of change are considered to result in a **major** effect on walkers and visitors, which in the context of this assessment is considered to be **significant**.

Table 13.28 Operational Effects at Viewpoint 1.2, The Haa, Wick of Skaw

Viewpoint 1.2, The Haa, Wick of Skaw Drawing 13.3.1.2: existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 860 m to the south east
LCT/CCA and Designations	LCT 353. Farmed and Settled Lowlands and Coast/ East Unst CCA, Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors/Residents of the Haa – High

Theoretical visibility	Proposed Project only

Location and Rationale for Selection

The viewpoint is located at the rear of Skaw Beach, to the north-east of Unst, looking south-east across the Wick of Skaw. The beach which lies towards the northern tip of British Isles is a popular location for visitors and for walkers accessing the northern coastline of Unst.

The following development currently influences the existing baseline:

- The derelict buildings and infrastructure associated with the former Skaw Radar Station both across the headland at Lamba Ness.
- The maritime navigation beacon on the Holm of Skaw.
- The radar radome on Saxa Vord hill to the west.

Description of Existing View

The existing view looks south-east across the Wick of Skaw to Lamba Ness. The sandy beach in the foreground gives way to the rocky coastline and cliffs along the edge of the peninsula. The tidal races are seen in the distance across the bay, beyond the headland, with standing waves and overfalls at certain states of tides which add local interest. Features of the former Radar Station on Lamba Ness are noticeable at the end of Lamba Ness including: the earth banked building of the former receiver building and the associated cluster of radar buildings.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and visitors who access the beach for recreation and who are more susceptible to changes in the view:

Value *– Medium*

Susceptibility to Change *– High*

- Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- The landform orientates principal views from Skaw Beach east towards the bay and the North Sea beyond.
- Visitors will be focussed on the surrounding scenery and views.
- Relative simplicity of landform and expansive coastal views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a Moderate.

Size or Scale

The Proposed Project will be seen extending across the headland between Inner Skaw and Lamba Ness, with the development at Inner Skaw contained from view, and with restricted visibility to the TEL Hangar. The new built form will appear on the horizon line to the south,

adding new noticeable features along the peninsula. The lightning masts will be seen as tall vertical elements punctuating the skyline. Launch pad three is illustrated in its extended pre-launch condition with the launch vehicle and strongback erected and the lightning masts extended in full. Launch pads one and two are shown in their retracted state. The base infrastructure around launch pads one and two is also seen on top of the peninsula. ***Geographical Extent*** The Proposed Project across the Proposed Project will be seen over a c.20° angle of view. Views of this nature will be experienced in views south from the beach at Skaw.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **substantial** magnitude of change are considered to result in a **major** effect on walkers and visitors which in the context of this assessment is considered to be **significant**.

Table 13.29 Effects at Viewpoint 1.3, The Garths, Lamba Ness

Viewpoint 1.3, The Garths, Lamba Ness **Drawing 13.3.1.3 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 320 m to the east
LCT/CCA and Designations	LCT 349. Major Uplands/ East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Cyclists – High Road Users - Medium
Theoretical visibility	Proposed Project only
Location and Rationale for Selection	
The viewpoint is located at the high point on Holsens Road, which connects between Norwick and Skaw Beach, located close to the south western site boundary. It has been selected to illustrate the effects on visitors, walkers and cyclists accessing the northern coastline of Unst. The following development currently influences the existing baseline: ➢ The derelict buildings and infrastructure associated with the former Skaw Radar Station between Inner Skaw and Lamba Ness.	

Description of Existing View
The existing view looks east across the rough pastures at Clinkapund and Inner Skaw and beyond to the Lamba Ness peninsula. The view looks beyond to the North Sea to the east and Nor Wick bay to the south. The tidal races are seen in the distance beyond the Lamba Ness peninsula. Features of the former Radar Station across Inner Skaw and Lamba Ness are noticeable including: the decontamination building to the left of the image, the earth banked building of the former power house building towards the centre of the peninsula and the earth banked receiver building and associated cluster of radar buildings on Lamba Ness.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers, cyclists and visitors accessing area for recreation and **Medium** for road users: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ Walkers and cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness. ➢ Views are expansive across the simple landscape of the peninsula and to the North Sea beyond. ➢ Visitors will be focussed on the surrounding scenery and views.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **Substantial**. ***Size or Scale*** The Proposed Project will be visible, with the large-scale hangars, gate house and associated out buildings seen in the foreground at Inner Skaw. Whilst the hangar buildings have a similar character to the modern barns seen within the wider Unst landscape their scale is larger, despite the absence of features in the landscape can be easily scaled by eye. The lightning masts will be seen as tall vertical elements however, they are seen against the backdrop of the sea beyond and are seen to recede in views. Launch pad three is illustrated in its extended pre-launch condition with the launch vehicle and strongback erected and the lightning masts extended in full. The TEL hangar is noticeable as new built form to the foreground. Launch pads one and two are contained from view though their lightning masts are visible. ***Geographical Extent*** The main structures at Inner Skaw are seen within a c.20° angle of view, with further elements of the Proposed Project seen as a localised pocket of development at Lamba Ness. Views of this nature will be experienced in views east from Holsens Road.

Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** and **medium** sensitivity and a **substantial** magnitude of change are considered to result in a **major** effect on Walkers, Visitors and Cyclists, and a **major/moderate** effect on Road Users which in the context of this assessment are considered to be s**ignificant**.

Table 13.30 Effects at Viewpoint 1.4, Car Park at The Taing, Norwick

Viewpoint 1.4, Car Park at The Taing, Norwick Drawing 13.3.1.4 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 800 m to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors/Residents – High
Theoretical visibility	Proposed Project only
Location and Rationale for Selection	
The viewpoint is located in the public car park at The Taing, Norwick Beach, looking east across the bay at Nor Wick. The beach and coastline are a popular destination for visitors and walkers and the viewpoint is representative of the nature of views experienced by residents at Booths. The following development currently influences the existing baseline: ➢ The derelict buildings and infrastructure associated with the former Skaw Radar Station as seen in more distant views across the peninsula to the north east at Lamba Ness.	
Description of Existing View	
The existing view looks across the bay at Nor Wick and to the peninsula to the north between Inner Skaw and Lamba Ness. The outcrop of rock on the beach at Norwick, The Taing, is seen at the northern edge of the beach in the foreground. The cliffs along the southern edge of the peninsula frame the view to the north, contrasting with the waters of Nor Wick below. Features of the former Radar Station are noticeable in the distance on Lamba Ness; the most noticeable of which is the earth banked receiver building.	

Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers, visitors and residents who access the area for recreation and residents of who are more susceptible to changes in the view: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Walkers and visitors will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness. ➢ The landform orientates principal views east towards the bay and the North Sea beyond. ➢ Visitors will be focussed on the surrounding scenery and views. ➢ Relative simplicity of landform and expansive coastal views.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **Moderate**. ***Size or Scale*** The hangars will be seen above the cliffs at Inner Skaw. The southernmost radome of the tracking station will be seen above the cliffs towards the middle of the peninsula. Launch pad three is illustrated in its extended pre-launch condition with the launch vehicle and strongback erected and the lightning masts extended in full, these elements are seen above the end of the peninsula at Lamba Ness. Launch pads one and two are hidden from view. Whilst parts of the Proposed Project will be visible above the peninsula, breaking the skyline, the careful approach to the use of colour in the facades will assist in the new structures being seen to recede in views against the typically grey skies. ***Geographical Extent*** Views of this nature will be experienced from the beach and coastline at Norwick.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **moderate** magnitude of change are considered to result in a **major/moderate** effect on walkers, visitors and residents, which in the context of this assessment is considered to be **significant**.

Table 13.31 Effects at Viewpoint 1.5, The Cemetery, Norwick

Viewpoint 1.5, The Cemetery, Norwick Drawing 13.3.1.5 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 1.2 km to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers/Visitors/Residents – High
Theoretical visibility	Proposed Project only
Location and Rationale for Selection	
The viewpoint is located at the north-eastern edge of the cemetery at Norwick which is raised on a platform above the adjoining farmland to the east of Norwick. The cemetery is a focus for local visits at Norwick and is representative of the nature of views experienced by residents. The following development currently influences the existing baseline: ➢ The derelict buildings and infrastructure associated with the former Skaw Radar Station as seen in more distant views across the peninsula to the north east at Lamba Ness.	
Description of Existing View	
The existing view looks north across the bay at Nor Wick, to the peninsula to the north between Inner Skaw and Lamba Ness, and to the North Sea beyond. The coastal views contrast with the foreground pastures. The Taing and Norwick beach are seen to the left of the view, beneath the cliffs at Braehead. Features of the former Radar Station are noticeable in the distance on Lamba Ness; the most noticeable of which is the earth banked receiver building on Lamba Ness, the earth banked structure of the power house to the west of Lamba Ness and the noticeable decontamination building at Inner Skaw.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and visitors who access the area for recreation and residents of who are more susceptible to changes in the view: ***Value*** *– Medium* ***Susceptibility to Change*** *– High*	

➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Walkers and visitors will be engaged in the experience of the landscape, with a strong awareness of their surroundings. ➢ Visitors will be focussed on the surrounding scenery and views.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **moderate**. ***Size or Scale*** The hangars will be seen above the cliffs at Inner Skaw. The southernmost two radomes of the tracking station will be seen above the cliffs towards the middle of the peninsula. Launch pad three is illustrated in its extended pre-launch condition with the launch vehicle and strongback erected and the lightning masts extended in full, these elements are seen above the end of the peninsula at Lamba Ness. The TEL Hangar is seen against the skyline to the west of Lamba Ness. Launch pads one and two are hidden from view. Whilst parts of the Proposed Project will be visible above the peninsula, breaking the skyline, the careful approach to the use of colour in the facades assist in the new structures being seen to recede in views against the typically light grey skies. ***Geographical Extent*** Views of this nature will be experienced from in and around the settlement at Norwick.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **moderate** magnitude of change are considered to result in a **major/moderate** effect on walkers, visitors and residents, which in the context of this assessment is considered to be **significant**.

Table 13.32 Effects at Viewpoint 1.6, B9087 Norwick

Viewpoint 1.6, B9087 Norwick **Drawing 13.3.1.6 shows: a) 90° existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 1.6 km to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA, Haroldswick and Skaw LLA

Viewpoint 1.6, B9087 Norwick Drawing 13.3.1.6 shows: a) 90° existing view and a panoramic photomontage of the Proposed Project.	
Receptor and Sensitivity to Change	Cyclists/Residents – High Road Users - Medium
Theoretical visibility	Proposed Project only

Location and Rationale for Selection

The viewpoint is located on the B9087/NCR1 between Saxa Vord and Norwick, adjacent to the entrance to the property at 'Virse'. The view represents views experienced by road users and cyclists and is also representative of the nature of views experienced by residents form the surrounding scattered crofting settlement.

The following development currently influences the existing baseline:

- The derelict buildings and infrastructure associated with the former Skaw Radar Station as seen in more distant views across the peninsula to the north east at Lamba Ness.
- Masts and radar equipment at the Ward of Norwick.

Description of Existing View

The existing view looks north across the settled farmland of Norwick Meadow and beyond to the settlement at Norwick, the bay at Nor Wick, the peninsula to the north between Inner Skaw and Lamba Ness, and the expansive North Sea beyond. Features of the former Radar Station are seen in relatively distant views to Lamba Ness and Inner Skaw, the most noticeable of which is the earth banked receiver building on Lamba Ness, the earth banked structure of the power house to the west of Lamba Ness and the noticeable decontamination building at Inner Skaw.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Cyclists and Residents of who are more susceptible to changes in the view, and **Medium** for Road Users:

***Value** – Medium*

- The B9087 forms part of National Cycle Route 1.

***Susceptibility to Change** – High*

- Residents are highly likely to be aware of any changes to their existing visual amenity.
- Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings.
- Motorists travelling through or past the landscape on roads will focus on the route corridor.

Viewpoint 1.6, B9087 Norwick Drawing 13.3.1.6 shows: a) 90° existing view and a panoramic photomontage of the Proposed Project. Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **moderate**. ***Size or Scale*** The hangars will be seen above the cliffs at Inner Skaw. The southernmost two radomes of the tracking station will be seen above the cliffs towards the middle of the peninsula. Launch pad three is illustrated in its extended pre-launch condition with the launch vehicle and strongback erected and the lightning masts extended in full, these elements are seen above the end of the peninsula at Lamba Ness. The TEL Hangar is seen against the skyline to the west of Lamba Ness. Launch pads one and two are hidden from view however the lightning masts break the skyline. ***Geographical Extent*** Views of this nature will be experienced along the B9087 between Saxa Vord and Norwick.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** and **medium** sensitivity and a **moderate** magnitude of change are considered to result in a **major/moderate** effect on cyclists and residents, and a **moderate** effect on Road Users, which in the context of this assessment is considered to be **significant** and **not significant** effects respectively.

Table 13.33 Effects at Viewpoint 1.7, Hill of Clibberswick

Viewpoint 1.7, Hill of Clibberswick Drawing 13.3.1.7 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 2.4 km to the north
LCT/CCA and Designations	LCT 355. Coastal Edge / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Walkers – High

Theoretical visibility	Proposed Project only

Location and Rationale for Selection

The viewpoint is located close to the summit of the Hill of Clibberswick, looking north across the Norwick. The headland is a popular route with walkers accessing the north eastern coastline of Unst.

The following development currently influences the existing baseline:

- The derelict buildings and infrastructure associated with the former Skaw Radar Station in distant views across the peninsula to the north at Lamba Ness.
- The maritime navigation beacon on the Holm of Skaw.
- The radar infrastructure at the Ward of Norwick, and the radome at Saxa Vord Hill (beyond the left-hand edge of the view).

Description of Existing View

The existing view looks north across Nor Wick to the peninsula between Inner Skaw and Lamba Ness, forming part of expansive views across the north eastern extent of Unst. The cliffs of the horns of Hagmark are seen in the foreground of the view. The viewpoint, at c.160m AOD, provides an elevated vantage point for views to the surrounding coastline. Features of the former Radar Station on Lamba Ness are noticeable including the following: the earth banked building of the former receiver building at the end of Lamba Ness; the concrete power house block seen on the crest of the peninsula; and the cluster of buildings including the decontamination building at Inner Skaw.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **high** for walkers who access the headland for recreation and are therefore more susceptible to changes in the view:

Value *– Medium*

Susceptibility to Change *– High*

- Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness.
- Elemental coastal scenery with expansive views.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be a **substantial**.

Size or Scale

The Proposed Project will be seen extending across the headland between Inner Skaw and Lamba Ness. The new built form will appear across the peninsula to the north, adding new

noticeable features. The radomes of the tracking station will be seen towards the centre of the peninsula. The lightning masts will be seen as tall vertical elements, seen against the sea beyond and will slightly recede in views. Launch pad three is illustrated in its extended pre-launch condition with the launch vehicle and strongback erected and the lightning masts extended in full. Launch pads one and two are shown in their retracted state, with the surrounding ancillary structures seen as distant features many of which are earth sheltered. The TEL hangar is seen in front of launch pad two, contrasting with the sea beyond. The base infrastructure around launch pad one is contained from view beyond Lamba Ness. ***Geographical Extent*** The components of the Proposed Project seen across the Proposed Project will extend over a c.45° angle of view. Views of this nature will be experienced from the elevated north facing flank of the Hill of Clibberswick.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **moderate** magnitude of change are considered to result in a **major/moderate** effect on walkers, which in the context of this assessment is considered to be **significant**.

Table 13.34 Effects at Viewpoint 1.8, Headland to the north of Saxa Vord Radar Station

Viewpoint 1.8, Headland to the north of Saxa Vord radar station **Drawing 13.3.1.8 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the Proposed Project	Proposed Project: 3.3 km to the east
LCT/CCA and Designations	LCT 355. Coastal Edge / Skaw CCA Herma Ness sub unit of the Shetland NSA
Receptor and Sensitivity to Change	Walkers – High
Theoretical visibility	Proposed Project – lightning masts only
Location and Rationale for Selection	
The viewpoint is located on the remote headland to the north of the Saxa Vord radar station. The headland is accessible only by foot, with occasional walkers accessing the northern coastline of Unst. The following development currently influences the existing baseline: ➢ The derelict radar equipment and fencing on the headland. ➢ The maritime navigation beacon on the Holm of Skaw seen in the distance.	

- The radome and buildings associated with the radar station at Saxa Vord Hill.

Description of Existing View
The existing view looks west across the northern flank of Saxa Vord Hill and the headlands at Ritten Hamar and Hill Ness to the Holm of Skaw and Inner Flae beyond at the north-eastern edge of Unst. The viewpoint, at c.150 m AOD, provides an elevated vantage point for views across the northern coastline of Unst.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **high** for walkers who access the headland for recreation and therefore more susceptible to changes in the view: ***Value*** *– High ((Herma Ness sub unit of the Shetland NSA)* ***Susceptibility to Change*** *– High* ➢ Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings and an expectation of remoteness. ➢ Elemental coastal scenery with expansive views.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be **negligible**. ***Size or Scale*** The tips of the lightning masts on launch pad 3 will be visible as very minor elements faintly visible extending above the line of cliffs above The Punds, only being visible during launch sequences when the lasts are extended. The remainder of the Proposed Project will be screened from view. ***Geographical Extent*** The lightning masts as shown on the ZTV in Drawing 13.2.1a over a very small area of the headland.
Potential for In-Combination Effects
No combined effects are predicted.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **negligible** magnitude of change are considered to result in a **minor** effect on walkers, which in the context of this assessment is considered to be **not significant**. This minor effect will only be experienced as a temporary effect during launch sequences on launch pad three.

Table 13.35 Effects at Viewpoint 1.9, A968 beneath Little Hoeg

Viewpoint 1.9, A968 beneath Little Hoeg Drawing 13.3.1.9 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 4.4 km to the north
LCT/CCA and Designations	LCT 350. Peatland and Moorland / East Unst CCA
Receptor and Sensitivity to Change	Cyclist – High Road users - Medium
Theoretical visibility	Proposed Project and LRCC
Location and Rationale for Selection	
The viewpoint is located on A968 as the route descends beneath Little Hoeg on the approach to Haroldswick. The viewpoint is representative of wider views for travellers using the road network on the north eastern extent of Unst. The following development currently influences the existing baseline: ➢ The radome and buildings associated with the radar station at Saxa Vord Hill. ➢ Telecommunications masts beside Little Hoeg.	
Description of Existing View	
The existing view looks north across Harold's Wick to Saxa Vord Resort on the ridge of land beneath Saxa Vord Hill and the Ward of Norwick. The Hill of Clibberswick frames the view to the right. The viewpoint, at c.54m AOD, provides a vantage point for views across the north eastern coastline of Unst.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Cyclists and Residents of who are more susceptible to changes in the view, and **Medium** for Road Users: ***Value** – Medium* ➢ The B9087 forms part of National Cycle Route 1. ***Susceptibility to Change** – High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings. ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor.	

Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **Slight**. ***Size or Scale*** The hangars will be seen on the distant horizon to the right of the Saxa Vord Resort. The hangar buildings have a similar character to the large modern barns seen within the wider Unst landscape although their scale is larger. The careful approach to the use of colour in the facades assist in the new structures being seen to recede in views against the typically light grey skies. ***Geographical Extent*** Views of this nature will be experienced along a short c.600m section of the A968 as crosses the low col between Baltasound and Haroldswick.
Potential for in-Combination Effects
There will be a **negligible** magnitude of change with a **minor** and **not significant** combined effects on Cyclists and Road Users.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **slight** magnitude of change are considered to result in a **moderate/minor** effect on Cyclists and Road Users, which in the context of this assessment is considered to be **not significant**.

Table13.35 Effects at Viewpoint 1.10, Hermaness Hill

Viewpoint 1.10, Hermaness Hill Drawing 13.3.1.10 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the Proposed Project	Proposed Project: 5.32 km to the east
LCT/CCA and Designations	LCT 349. Major Uplands/ Remote High Cliffs SCA Herma Ness sub unit of the Shetland NSA
Receptor and Sensitivity to Change	Walkers/Bird Watchers – High
Theoretical visibility	None

Location and Rationale for Selection
The viewpoint is located on the summit of Hermaness Hill at the remote Herma Ness headland to the west of the Saxa Vord radar station. The headland, which is accessible only by foot, forms part of the Hermaness National Nature Reserve popular with wildlife watchers and walkers accessing the north-western coastline of Unst. The following development currently influences the existing baseline: ➢ The radome and buildings associated with the radar station at Saxa Vord Hill. ➢ The radar equipment on the summit of the Ward of Norwick.
Description of Existing View
The existing view looks west to Saxa Vord Hill and the Ward of Norwick. The viewpoint, at c. 200 m AOD, provides an elevated vantage point for views across the north western coastline of Unst.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for walkers and wildlife watchers who access the headland for recreation and therefore more susceptible to changes in the view: ***Value*** *– High ((Herma Ness sub unit of the Shetland NSA)* ***Susceptibility to Change*** *– High* ➢ Walkers and wildlife watchers will be engaged in the experience of the landscape and wildlife, with a strong awareness of their surroundings and an expectation of remoteness. ➢ Elemental coastal scenery with expansive views.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be **no change**. ***Size or Scale*** The Proposed Project will be screened from view. ***Geographical Extent*** As shown on the ZTV in Drawing 13.2.1a the peninsula at Herma Ness experiences no visibility of the Proposed Project.
Potential for In-Combination Effects
No combined effects are predicted.

Significance of Effects
There will be no change to views experienced at Herma Ness.

LRCC Viewpoints, Viewpoints 2.1 – 2.5

Table 13.36 Operational Effects at Viewpoint 2.1, Minor road at Valsgarth

Viewpoint 3.1, Minor road at Valsgarth **Drawing 13.3.2.1 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the LRCC	LRCC: 400 m to the west
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Cyclists / Residents – High Road Users - Medium
Theoretical visibility	Proposed Project and LRCC
Location and Rationale for Selection	
The viewpoint is located on the minor road at Valsgarth to the south-east of the former RAF base at Saxa Vord. The viewpoint is representative of the range of view in and around Saxa Vord for Residents and Road Users. The following development currently influences the existing baseline: ➢ The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort. ➢ The clusters of radar equipment on the Sothers Field.	
Description of Existing View	
The existing view looks north west to the southern edge of the Saxa Vord Resort, the pastures and scattered properties at Valsgarth are seen in the foreground. The Shetland Reel Distillery and the former Valhalla Brewery buildings are seen to their rooflines, set at a slightly lower level than the main resort buildings. The moorland hills at Housi Field and Sothers Field rise to the rear.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **high** for Residents and Cyclists who are more susceptible to changes in the view, and **medium** for Road Users: ***Value*** *– Medium* ***Susceptibility to Change*** *– High*	

➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings. ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be **negligible**. ***Size or Scale*** There will be no significant change to the view. ***Geographical Extent*** Views to the refurbishment works will be experienced from Valsgarth.
Potential for In-Combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
No effects.

Table 13.37 Effects at Viewpoint 2.2, Methodist Church, Valsgarth / Saxa Vord

Viewpoint 3.2, Methodist Church, Valsgarth/Saxa Vord **Drawing 13.3.2.2 existing view and a panoramic photomontage of the Proposed Project.**	
Distance and Direction to the LRCC	LRCC: 520 m to the south west
LCT/CCA and Designations	LCA 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Residents/Visitors/Walkers – High
Theoretical visibility	LRCC only
Location and Rationale for Selection	
The viewpoint is located on elevated ground adjacent to the Methodist Church at Sunnyside, beside the Saxa Vord Resort. The viewpoint is representative of the range of views in and around Saxa Vord for Residents. The following development currently influences the existing baseline: ➢ The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort.	

Description of Existing View
The existing view looks west to the rear of the clusters of development at the Saxa Vord Resort, pastures and the Saxa Vord games court are seen in the foreground. The moorland hills at Housi Field and Sothers Field rise to the rear. The low-lying farmland art Ungirsta extends to the left of the view.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for residents who are more susceptible to changes in the view: ***Value*** – *Medium* ***Susceptibility to Change*** – *High* ➢ Residents/Visitors are highly likely to be aware of any changes to their existing visual amenity. ➢ Walkers will be engaged in the experience of the landscape, with a strong awareness of their surroundings.
Magnitude of Change
There will be no effect on this view as the former Valhalla Brewery Building is screened from view behind the buildings of Saxa Vord Resort.
Potential for In-Combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
There will be no effect on this Viewpoint.

Table 13.38 Operational Effects at Viewpoint 2.3, B9087 adjacent to the Unst Heritage Centre, Haroldswick

Viewpoint 3.3, B9087 adjacent to the Unst Heritage Centre, Haroldswick Drawing 13.3.2.3 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to LRCC	LRCC: 850 m to the north east
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA

Receptor and Sensitivity to Change	Cyclists / Residents – High Road Users - Medium
Theoretical visibility	LRCC only

Location and Rationale for Selection

The viewpoint is located on the B9087 adjacent to the Unst Heritage Centre. The viewpoint is representative of the range of views between Haroldswick and Saxa Vord/Valsgarth for Residents and Road Users.

The following development currently influences the existing baseline:

- The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort.
- The clusters of radar equipment on the Ward of Norwick.

Description of Existing View

The existing view looks to the north east across the open farmland between Haroldswick and Saxa Vord Resort, beneath the rising moorland flank of Sothers Field and the Ward of Norwick. The settlement at Valsgarth/Saxa Vord Resort extends across the locally elevated middle ground.

Determination of Visual Sensitivity

The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Residents and Cyclists who are more susceptible to changes in the view, and **Medium** for Road Users:

Value *– Medium*

Susceptibility to Change *– High*

- Residents are highly likely to be aware of any changes to their existing visual amenity.
- Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings.
- Motorists travelling through or past the landscape on roads will focus on the route corridor.

Magnitude of Change

The overall magnitude of change on receptors at this viewpoint will be **negligible**.

Size or Scale

No prominent long-term effects are expected.

Geographical Extent

Views will be experienced locally to the south-west of Saxa Vord.

Potential for In-Combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
The combination of the individual judgements of **high** sensitivity and a **negligible** magnitude of change are considered to result in a **minor** effect on Residents, Cyclists and Road Users, which in the context of this assessment is considered to be **not significant**.

Table 13.39 Effects at Viewpoint 2.4, Minor road at Houlanbrindy

Viewpoint 3.4, Minor road at Houlanbrindy Drawing 13.3.2.4 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the LRCC	LRCC: 1 km to the south west
LCT/CCA and Designations	LCA 349. Major Uplands Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Cyclists – High Road Users - Medium
Theoretical visibility	LRCC only
Location and Rationale for Selection	
The viewpoint is located on the minor road which leads above Norwick Meadow to join into Holsens Road. The viewpoint is representative of the range of views in and around Saxa Vord/Northdale for Road Users. The following development currently influences the existing baseline: ➢ The complex of buildings associated with the former Saxa Vord RAF base, now forming part of the Saxa Vord Resort. ➢ The telecommunications masts at Little Hoeg.	
Description of Existing View	
The existing view looks south across the pastures at Northdale to the distinctive rooflines of the former RAF base at Saxa Vord. Views to Saxa Vord are seen against the northern flanks of the Hill of Clibberswick, Little Hoeg and Muckle Hoeg. The North Sea is seen beyond to the left of the view.	

Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Cyclists who are more susceptible to changes in the view, and **Medium** for Road Users: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings. ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor.
Magnitude of Change
There will be no effect on this view as the former Valhalla Brewery Building is screened from view behind the building of the Shetland Reel Distillery.
Potential for In-Combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
There will be no effect on this Viewpoint.

Table 13.40 Effects at Viewpoint 2.5, Minor road, off the B9087 at Norwick

Viewpoint 3.5, Minor road, off the B9087 at Norwick Drawing 13.3.2.5 existing view and a panoramic photomontage of the Proposed Project.	
Distance and Direction to the LRCC	LRCC: 1.1 km to the west
LCT/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Cyclists / Residents – High Road Users - Medium
Theoretical visibility	None

Location and Rationale for Selection
The viewpoint is located on the minor road off the B9087, at Norwick Meadow, looking west towards the Saxa Vord Resort and Northdale. The viewpoint is representative of the range of views in and around Norwick for Residents and Road Users.
Description of Existing View
The existing view looks west across the fields of pasture west of Norwick towards the Saxa Vord Resort. The background is framed by the rising hillside at Crussa Field and Valla Field beyond.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for Residents and Cyclists who are more susceptible to changes in the view, and **Medium** for Road Users: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Cyclists will be engaged in the experience of the landscape, with a strong awareness of their surroundings. ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor.
Magnitude of Change
There will be no visibility to the LRCC which is contained from view by built form at Saxa Vord and the local ridgeline.
Potential for In-combination Effects
There will be no combined effects from this viewpoint.
Significance of Effects
There will be no effect on this Viewpoint.

Summary of Effects on Viewpoints

13.7.17 Table 13.41 lists and summarises effects on the viewpoints assessed above. It sets out their sensitivity to change, the magnitude of change that will arise as a result of the Proposed Project, and the level of resultant effects and their significance.

Table 13.41 Summary of Effects on Viewpoints

Viewpoint	Receptor and Sensitivity	Magnitude of Change	Level of Effect	Significance
Proposed Project, Viewpoints – 1.1 – 1.10				
1.1 - Bluejibs above the Wick of Skaw	Walkers/Visitors – High	Substantial	Major	**Significant**
1.2 - The Haa, Wick of Skaw	Walkers/Visitors/ Residents – High	Substantial	Major	**Significant**
1.3 - The Garths, Lamba Ness	Walkers/Cyclists – High Road Users - Medium	Substantial	**Major** - Walkers, Visitors and Cyclists **Major/Moderate** - Road Users	**Significant**
1.4 - Car park at The Taing, Norwick	Walkers/Visitors/ Residents – High	Substantial	**Major** - Walkers, Visitors and Residents	**Significant**
1.5 - The cemetery, Norwick	Walkers/Visitors/ Residents – High	Moderate	**Major/Moderate** - Walkers, Visitors and Residents	**Significant**
1.6 - B9087 Norwick	Residents/Cyclists – High Road Users - Medium	Moderate	**Major/Moderate** – Residents and Cyclists **Moderate** - Road Users	**Significant** Not significant
1.7 - Hill of Clibberswick	Walkers – High	Moderate	**Major/Moderate** - Walkers	**Significant**
1.8 - Headland to the north of Saxa Vord radar station	Walkers – High	Negligible	**Minor** - Walkers	Not significant
1.9 - A968 beneath Little Hoeg	Cyclists – High Road Users - Medium	Slight	**Moderate/Minor** – Cyclists and Road Users	Not significant
1.10 - Hermaness Hill	Walkers/wildlife Watchers – High	No Change	None	No effect

13.8 Assessment of Night-time Lighting Effects

13.8.1 The following section provides an overview of the predicted effects of night-time lighting at the Proposed Project.

13.8.2 Light pollution is a recognised problem in the UK, with lighting potentially contributing to an adverse effect on peoples' views, including their enjoyment of the night skies. SNH has noted the need to be cautious when proposing lighting in the UK's darker, more sensitive landscapes.

13.8.3 Night-time lighting will be required on the site for safety during launch cycles. The need for lighting will extend visibility of the Proposed Project into hours of darkness. Outside of Launch Cycles the lighting on site will be reduced to the minimum required for site security and occasional maintenance operations.

Baseline

13.8.4 The baseline environment of Shetland and of the site is generally dark and relatively light free at night, with the only lighting being associated with settlements and residential properties, lighting around the ferry terminals and piers (e.g., at Baltasound), and infrastructure such as fish farms or industrial operations such as the Sullom Voe Oil Terminal. Lighting on vehicles on roads, and on ferries at night, as well as on channel or hazard marker buoys in the sea between the islands also influences the night sky. Relative to the rest of the UK however, Shetland is characterised by very dark skies.

Assessment

13.8.5 Whilst lighting on the Proposed Project Launch Site will be reduced to a minimum with cut off lighting used wherever possible there will be times when elements of the site and in particular the launch pads and launch vehicles will need to lighted with directional lighting. The lights at the launch pads have the potential to be seen in clear conditions over long distances.

13.8.6 Shetland has long hours of daylight in the summer months, when the effects of safety lighting at the Proposed Project will be minimal, but there will be long hours of darkness in winter when the effects will extend over longer durations. In Shetland in winter at this latitude it can be dark from 3pm through to 9am, which includes times when people will be active and able to be affected by the proposed lighting.

13.8.7 Lighting may also be seen to interfere with natural phenomena such as the Northern Lights, when it occurs.

13.8.8 As such, the effects of lighting on night-time views have the potential to be significant, particularly in closer views and during launch cycles. It has the potential to have a significant effect during hours of darkness at all locations within up to approximately 1-2 km (depending upon atmospheric conditions) where the Proposed Project is visible.

Seasonal variation in effects

13.8.9 The effect will be more noticeable and significant in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will be not significant. Between these two extremes, the duration of lighting required and thus the level of significance of effects will gradually increase as the natural daylight tapers off.

Supporting Graphics – Night-time lighting Visualisations

13.8.10 Drawings are provided to illustrate the effects of lighting. The following viewpoint Drawings have been prepared to illustrate the effects of night-time lighting at two selected viewpoints, representative of the local residential clusters that will experience direct views towards the Proposed Project.

- Night-time Lighting Viewpoint 1: Virse, Norwick
  - Drawing 13.3.1a: Virse, Norwick – 90° Existing View (Dusk) and 90° Predicted Photomontage View (Cylindrical)
- Night-time Lighting Viewpoint 2: Skulhus, Sunnyside/Saxa Vord Resort
  - Drawing 13.3.2a: Skulhus, Sunnyside/Saxa Vord Resort – 90° Existing View (Darkness) and 90° Predicted Photomontage View (Cylindrical)

13.8.11 The individual assessment from these representative locations is provided below.

Table 13.42 Effects at Night-time Lighting Viewpoint 1, Virse, B9087 Norwick

Night-time Lighting Viewpoint 1, Virse, B9087 Norwick Drawing 13.3.1 existing view and a panoramic photomontage of the Proposed Project (Darkness).	
Distance and Direction to the Proposed Project	Proposed Project: 2 km to the north east
LCA/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Residents – High Road Users - Medium
Theoretical visibility	Proposed Project
Location and Rationale for Selection	
The viewpoint is located on the B9087/NCR1 between Saxa Vord and Norwick, adjacent to the entrance to the property at 'Virse'. It has been selected to illustrate the effects of night-time lighting on local residents.	
Description of Existing View	
The existing view looks north across the settled farmland of Norwick Meadow and beyond to the settlement at Norwick, the bay at Nor Wick, the peninsula to the north between Inner Skaw and Lamba Ness, and the expansive North Sea beyond. Lighted windows visible at the scattered properties at Norwick are the only visible artificial light sources.	
Determination of Visual Sensitivity	
The sensitivity to change associated with the Proposed Project at this location is considered to be **High** for residents of who are more susceptible to changes in the view, and **Medium** for Road Users: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor.	
Magnitude of Change	
The overall magnitude of change on receptors at this viewpoint will be a **Moderate**. ***Size or Scale*** The proposed lighting will be visible in the distance varying from being dimly visible at low light, more resolved and noticeable at dusk, to being seen as a clearly seen at darkness.	

Light sources are likely to include: ➢ Cut off lighting at the launch pads. ➢ Directional lighting onto the launch vehicle, strongback and the lightning masts. ➢ Low level lighting at the hangars and gate house. ***Geographical Extent*** Views to the lighting will be experienced along the B9087 between Saxa Vord and Norwick. ***Duration*** The effect will be more noticeable and significant in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will not be significant. Between these two extremes, the duration and thus level of significance of effects will gradually increase as the natural daylight tapers off again.
Significance of Effects
The combination of the individual judgements of **high** and **medium** sensitivity and a **moderate** magnitude of change are considered to result in a **major/moderate** effect on Residents, and a **moderate** effect on Road Users, which in the context of this assessment are considered to be **significant** and **not significant** effects respectively.

Table 13.43 Operational Effects at Night-time Lighting Viewpoint 2, Skulhus, Sunnyside/Saxa Vord.

Night-time Lighting Viewpoint 2, Skulhus, Sunnyside/Saxa Vord. **Drawing 13.3.2 existing view and a panoramic photomontage of the Proposed Project (Dusk).**	
Distance and Direction to the Proposed Project	Proposed Project: 1.6 km to the north east
LCA/CCA and Designations	LCT 354. Farmed and Settled Voes and Sounds / East Unst CCA Haroldswick and Skaw LLA
Receptor and Sensitivity to Change	Residents – High Road Users - Medium
Theoretical visibility	Proposed Project
Location and Rationale for Selection	
The viewpoint is located at the edge of Saxa Vord / Sunnyside, adjacent to the property at ‘Skulhus’. It has been selected to illustrate the effects of night-time lighting on local residents.	

Description of Existing View
The existing view looks to the north-east across the scattered settlement between Saxa Vord and Norwick. The peninsula between Inner Skaw and Lamba Ness is partly seen on the skyline below the tapering ridgeline of The Ward of Norwick. Lighted windows visible at the properties in the foreground are the only visible artificial light sources.
Determination of Visual Sensitivity
The sensitivity to change associated with the Proposed Project at this location is considered to be **high** for Residents of who are more susceptible to changes in the view, and **medium** for Road Users: ***Value*** *– Medium* ***Susceptibility to Change*** *– High* ➢ Residents are highly likely to be aware of any changes to their existing visual amenity. ➢ Motorists travelling through or past the landscape on roads will focus on the route corridor.
Magnitude of Change
The overall magnitude of change on receptors at this viewpoint will be a **moderate**. ***Size or Scale*** The proposed lighting will be visible in the distance varying from being dimly visible at low light, more resolved and noticeable at dusk, to being seen as a clearly seen at darkness. Light sources are likely to include: ➢ Cut off lighting at the launch pads. ➢ Directional lighting onto the launch vehicle, strongback and the lightning masts. ➢ Low level lighting at the Hangars and gate house. ***Geographical Extent*** Views to the lighting will be experienced along the B9087 between Saxa Vord and Norwick. ***Duration*** The effect will be more noticeable and significant in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will not be significant. Between these two extremes, the duration and thus level of significance of effects will gradually increase as the natural daylight tapers off again.

Significance of Effects

The combination of the individual judgements of **high** and **medium** sensitivity and a **moderate** magnitude of change are considered to result in a **major/moderate** effect on Residents, and a **moderate** effect on Road Users, which in the context of this assessment are considered to be **significant** and **not significant** effects respectively.

Summary

13.8.12 Shetland has long hours of daylight in the summer months, when the effects of safety lighting and task lighting will be minimal, but long hours of darkness in winter when the effects will extend over longer durations. In Shetland in winter at this latitude it can be dark from 3pm through to 9am, which includes times when people will be active and able to be affected by the proposed lighting.

13.8.13 Lighting may also be seen to interfere with natural phenomena such as the Northern Lights when they occur.

13.8.14 As such, the effects of lighting on night-time views is likely to be significant, particularly in closer views. It is likely to be significant during hours of darkness at locations within approximately 1-2 km where visible.

13.8.15 The effect will be more noticeable and significant in winter months, when people are active during hours of darkness. In summer months however, when the islands are typically more populated with tourists and more people will be outside, most people will be asleep during the very short hours of darkness at this latitude, and the effect of the lighting will be not significant. Between these two extremes, the duration and intensity of lighting and thus level of significance of effects will gradually increase as the natural daylight tapers off.

13.9 Cumulative Landscape and Visual Assessment Effects

13.9.1 Cumulative effects can be either inter-project or intra-project effects.

13.9.2 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, it is considered that there are no potential inter-project cumulative effects as there are no other existing or proposed developments in the LVIA Study Area s for air quality.

13.9.3 Shetland Islands Council was contacted during the planning application stage of the Proposed Project and confirmed that there are no committed development or infrastructure projects on the Island which should be considered in the assessment.

13.9.4 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. In the context of LVIA this is the assessment of in-combination effects, incorporated into the main LVIA, with separate judgements for the combined effects presented within each of the tables throughout, for each landscape and visual receptor. In summary, there will be short term combined effects on the settlement at Saxa Vord and areas around Northdale where parts of the Proposed Project will be seen in combined views and successive views; however, these effects are not significant.

13.10 Summary

13.10.1 A Landscape and Visual Impact Assessment has been undertaken for the Proposed Project. It sets out the predicted effects on the landscape, which, in the context of Shetland and this assessment, also includes effects on coastal and seascape character.

13.10.2 The assessment includes consideration of effects upon designated landscapes including the Shetland NSA and other locally designated landscapes such the draft LLAs.

13.10.3 From a visual perspective, the assessment considers effects upon residents at settlements, users of roads and recreational routes, which include tourists. This was informed by assessment of visual effects at a series of representative viewpoints, which were agreed with NatureScot and Shetland Islands Council.

13.10.4 The assessment of in-combination effects between the component parts of the Proposed Project is incorporated into the main assessment of landscape and visual effects. Some limited in-combination interactions will occur.

13.10.5 The proposed launch pads will need to be lighted at night for a short term during individual launch cycles for reasons of safety. The lighting will extend visual effects into hours of darkness for local visual receptors.

13.10.6 Whilst it is always necessary to take account of and to balance the wide range of technical and environmental requirements, it is also a requirement to seek to optimise the layout design through mitigation measures embedded into the project design to reduce the resulting effects from a landscape and visual perspective. Landscape and visual input into the Proposed Project design has been provided through the design development stages of the project. These measures include the careful selection of colour in the proposed built forms, sensitive use of construction materials, and a careful approach to the manipulation of the land form to accommodate the new structures.

Summary of Effects on the Landscape Resource

Effects on Landscape Fabric

13.10.7 Effects on the fabric of the landscape will be limited in extent. The physical changes to the landscape, such as the construction of access tracks, launch pads, and buildings will occupy only a small portion of the overall site area and the existing use of the land for grazing will persist. The Proposed Project will be operated in such a way as to mitigate the extent of any unnecessary damage, potential soil erosion or indirect off-site effects due to changed surface or groundwater conditions.

13.10.8 The landscape is of Medium sensitivity, given the presence of the sensitive remains of the former Skaw Radar Station. Operation the Proposed Project is considered to have a Substantial magnitude of change. There will be major/moderate and significant effects on the fabric of the application sites in and around the immediate vicinity of the Proposed Project.

Effects on Landscape Character

13.10.9 The Proposed Project Launch Site includes parts of the 355 - Coastal Edge Landscape Character Type (LCT) and 349 - Major Uplands LCT as identified in the Scottish Landscape Character Types Mapping.

13.10.10 The Proposed Project is located within the Coastal Edge LCT and the eastern edge of the Major Uplands LCT and the implementation of the development will introduce additional built form and infrastructure to the peninsula between inner Skaw and Lamba Ness within the context of the derelict structures of the former Skaw Radar Station. The new buildings and infrastructure will reinforce development as a component of the prevailing landscape character. Although the Proposed Project will add to the influence of development on the peninsula, the presence of existing development will reduce the magnitude of change on the character and qualities of the LCTs.

13.10.11 Within the Coastal Edge LCT, there will be a locally Substantial magnitude of change, which in combination with the Medium/High sensitivity of the landscape, is considered to result in a locally major/moderate and significant effect across the immediate site area and the LCT.

13.10.12 The rising ridgeline of the Ward of Norwick is open to direct views to the Proposed Project and there will be direct and indirect effects on the character of the Major Uplands LCT. There will a locally Substantial magnitude of change, which in combination with the High sensitivity of the landscape, is considered to result in a locally major and significant effect across the immediate site area and a generally major/moderate and significant effect across the eastern extent of the LCT.

13.10.13 Whilst topography limits the influence of the Proposed Project there will be indirect impacts on the perceived qualities and characteristics of the Skaw unit of the Farmed and Settled Lowlands and Coast LCT to the north and the Norwick-Valsgarth area of the Farmed and Settled Voes and Sounds LCT to the south.

13.10.14 The Proposed Project between Inner Skaw and Lamba Ness will be seen in partial views, as new structures and buildings protruding above and along the peninsula, reinforcing the influence of development. From the Farmed and Settled Lowlands and Coast LCT and the Farmed and Settled Voes and Sounds LCT there will be a generally Slight magnitudes of change, which in combination with the High/Medium and Medium sensitivities respectively of the landscape types, is considered to result in a moderate and not significant effect.

13.10.15 During launch cycles the lightning masts, hardbacks and launch vehicles, erected at separate times on each of the launch pads, will be seen as prominent structures which will influence the setting of both LCTs. The launch event will give rise to short term increases in the magnitude of change experienced from the Farmed and Settled Lowlands and Coast LCT and the Farmed and Settled Voes and Sounds LCT, with a moderate magnitude of change, which in combination with the high/medium and medium sensitivities respectively of the landscape types, is considered to result in temporary locally major/moderate and significant effects. However, it is noted that these effects will be very short term.

13.10.16 There will also be areas of inter-visibility with the elevated coastal LCTs including the Blue Jibs area of the Coastal Edge LCT to the north, and the north facing flank of the Hill of Clibberswick to the south which includes sections of the Coastal Edge LCT and Peatland and Moorland LCT. Actual influence on the perception of landscape character is reduced by distance and there will be a Slight magnitude of change, which in combination with the high/medium and medium sensitivities respectively of the landscape types, is considered to result in locally moderate and not significant effects.

13.10.17 Beyond 3 km, due to the effect of topography which provides containment to the site and also the effect of distance, the Proposed Project will be a less visible element in the landscape. The resultant effects on landscape character will only give rise to slight or negligible magnitudes of change beyond 3 km with effects on landscape character being not significant.

Effects on Coastal and Seascape Character

13.10.18 The Proposed Project is located between the Skaw and East Unst Coastal Character Areas (CCA), and the Islands, Sounds and Voes Seascape Character Area (SCA) lies to the east. The implementation of the Proposed Project will introduce additional development to the peninsula between inner Skaw and Lamba Ness within the context of the derelict structures of the former Skaw Radar Station. The new buildings and infrastructure and will reinforce the perception of development as a component of the prevailing coastal/seascape character.

13.10.19 There will be locally moderate magnitudes of change on these CCAs/SCA, which in combination with the High sensitivity of the coastline/seascape, is considered to result in a locally major/moderate and significant effects across the CCAs/SCA within the Wick of Skaw to the north and Nor Wick to the south and across the open sea to the east. As with the effects on landscape character there will be a greater short-term magnitude of change experienced from the CCAs/SCA during launch cycles with the temporary infrastructure of extended lightning masts, strongback and launch vehicles appearing as prominent temporary elements above the low profile of the coastal peninsula.

Effects on Designated Landscapes

13.10.20 Potential effects on the quality and setting of designated landscapes within the LVIA Study Area were assessed, in particular relating to the Shetland NSA, LLAs and Inventory Gardens and Designed Landscapes.

13.10.21 Locally major/moderate and significant effects are predicted upon the coastal edges of the Haroldswick and Skaw Local Landscape Area.

13.10.22 Minor and not significant effects are also predicted on a very limited area of the Hermaness sub-unit of the Shetland NSA where there will be very minor visibility of the lightning masts of Launch Pad 3, visible only during a launch cycle, moderated by the distinct separation of the Proposed Project from the designation and the diverse nature of views. There will not be important changes to the special qualities of the Shetland NSA. A detailed assessment of effects on the Shetland NSA is included at Appendix 13.5.

13.10.23 No significant effects as a result of the Proposed Project will occur in relation Inventory Gardens and Designed Landscapes.

Summary of Effects on Visual Amenity

13.10.24 The study included an assessment of the effects of the Proposed Project upon settlements, transport corridors and viewpoints representative of a range of receptors within the LVIA Study Area.

Effects on Settlements, Transport Corridors and Recreational Routes

13.10.25 Effects were assessed on visual amenity from settlements. It is predicted that there will be major/moderate and significant effects from the settlements at Booths, Norwick/Kirkaton and the north-eastern edge of Saxa Vord/Valsgarth. This effect is moderated by the existing presence of the structures of the former Skaw Radar Station development in the landscape, the effects of distance and the context of the Proposed Project within expansive and diverse coastal views.

13.10.26 During launch cycles the lightning masts, strongbacks and launch vehicles, erected at separate times on each of the launch pads, will be seen as prominent structures which will influence views from Norwick and the north-eastern edge of Saxa Vord/Valsgarth. The launch cycle will give rise to short term increases in the magnitude of change.

13.10.27 Similar effects will be experienced by cyclists on the National Cycle Route 1 using the B9087 and also the minor road, Holsens Road, leading on from Norwick to Skaw.

13.10.28 Effects assessed on visual amenity from other settlements, roads and long-distance cycle ways within the LVIA Study Area, are concluded to be not significant.

Effects on Viewpoints

13.10.29 The nature of the visibility of the Proposed Project was also assessed from 15 viewpoints. The viewpoints included settlements, route corridors, landmarks, hill summits and other visitor attractions.

13.10.30 The assessment of the viewpoints concluded that there will be significant effects on visual amenity from six of the selected viewpoints as follows:

- Viewpoint 1.1, Coastal footpath above Bluejibs and the Wick of Skaw: From the headland at Blue Jibs to the north of Skaw Beach the Proposed Project be seen in its full extent along the peninsula between Inner Skaw and Lamba Ness adding new built form within the remnant structures of the Skaw Radar Station and introducing significant local change with the outlines of the new hangars prominent on the skyline of the peninsula.

- Viewpoint 1.2, The Haa, Wick of Skaw, and Viewpoint 1.4, Car Park at The Taing, Norwick: From Skaw Beach to the north of the peninsula and from Taing Beach to the south the Proposed Project will be seen as new vertical elements visible along the profile of the peninsula.
- Viewpoint 1.3, Holsens Road, Clinkapund above the site entrance to Lamba Ness: The viewpoint is located at the western edge of the Proposed Project and affords a locally elevated position across the site between Inner Skaw and Lamba Ness. The proposed large hangars will be as noticeable new large scale-built form on the site.
- Viewpoint 1.5, Norwick Cemetery: The viewpoint is located at the eastern edge of the settlement at Norwick within Norwick Cemetery and in a slightly elevated position affording a direct view across Nor Wick to the peninsula to the north. The proposed hangar at the western sector of the site will be prominent on the skyline above the beach at Taing, whilst the TEL hangar, and the lightning mast will be visible as new vertical elements visible along the profile of the peninsula.
- Viewpoint 1.6, B9087, Norwick: Similar views will be experienced from the scattered houses at the north-eastern edge of Valsgarth/Saxa Vord.
- Viewpoint 1.7, Hill of Clibberswick: This viewpoint from the northern side of the Hill of Clibberswick illustrates the effect on view that will be experienced by recreational walkers accessing the elevated coastline to the south of Nor Wick. The elevated viewpoint looks down onto the peninsula and the Proposed Project will be noticeable in views.

13.10.31 At each of these viewpoints, during launch cycles, the lightning masts, strongbacks and launch vehicles, erected at separate times on each of the launch pads, will be seen as further prominent structures in these views. There will also be associated temporary night-time lighting effects during each launch cycle.

13.10.32 From more distant viewpoint locations, the Proposed Project will appear in a large-scale and diverse landscape/coastal/seascape setting, which can accommodate the level of change associated with the Proposed Project and which will not give rise to further significant effects on visual amenity. The Proposed Project will recede within wider panoramic views, particularly with distance.

13.10.33 The Proposed Project is focussed away from the scattered settlement and coastal crofting land and is positioned on the Lamba Ness peninsula. The site has previously been the focus for the large-scale development of the wartime Skaw Radar Station with many of the original structures, buildings and tracks remaining evident in this coastal landscape. The Proposed Project has been carefully planned to retain the integrity of the remaining Skaw Radar facility, by using the existing site access and by positioning the proposed built forms in less prominent positions within the landscape and, avoiding the remains of the Skaw Radar Station where possible. Whilst the effects will be significant locally to the site, and for some visual receptors in local views to the site, it is considered that these can be accommodated in this open, diverse coastal landscape.

Conclusion

13.10.34 A number of significant effects are predicted including significant landscape effects on the landscape character of the site and its surroundings, visual effects on residents at settlements and tourists including recreational walkers. However, it is noted that the likely significant landscape effects identified are all inherently associated with the SaxaVord Spaceport infrastructure, rather than operation of the Proposed Project. They carry over into AEE only by LSVIA having been initially scoped into the assessment and by nature of the continued operation of the Spaceport by the Applicant. All significant residual effects (and potential alternatives) have been assessed by Shetland Islands Council and the relevant statutory consultees (including HES, NatureScot and SEPA) during the planning application stage of the SaxaVord Spaceport and the Spaceport found to be suitable with the development plans and mitigation measures outlined within this AEE.

13.10.35 As the AEE is concerned with the operational phase of the Proposed Project only, it is considered that the significant effects identified have been appropriately dealt with through the planning process and subsequent planning conditions and need not be considered further within the AEE. As such the findings of this AEE are that there are no significant operational effects of concern from the Proposed Project.

13.11 References

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Appendix 2.4 Justification for no further assessment of Population and Human Health

1. Introduction

1.1.1 Effects on Human Health from the Proposed Project are discussed in detail in the relevant technical chapters of this AEE Report - Air Quality (Chapter 7) and Noise (Chapter 8).

1.1.2 The effect of the Proposed Project on Population has been scoped out of the AEE Report. The Proposed Project must be considered as one part of the wider SaxaVord Spaceport development, which has already been the subject of an AEE Report. The SaxaVord Spaceport AEE Report found no adverse effects in the Population and Human Health chapter and those findings can be relied upon for the Proposed Project.

1.1.3 However, the SaxaVord Spaceport AEE Report did identify beneficial effects, including significant beneficial effects for Unst. The Proposed Project is expected to contribute to these beneficial effects and so this appendix summarises that contribution, in particular the socio-economic effects including the economic impacts associated with its operation.

1.1.4 Whilst the Proposed Project is part of the wider SaxaVord Spaceport development, with its associated environmental budget of 30 launches per year, in the context of this assessment effects on population have been assessed in isolation i.e., as the direct and in-direct effects arising solely from 10 launches of the Orbex PRIME Launch Vehicle from SaxaVord Spaceport in any given year.

1.1.5 This appendix is structured as follows:

- Section 2 sets out the relevant strategic context for the population effects;
- Section 3 describes the assessment methodology;
- Section 4 summarises the baseline socio-economic and tourism conditions;
- Section 5 assesses the potential effects of the Proposed Project;
- Section 6 describes the cumulative impacts of SaxaVord Spaceport; and,
- Section 7 provides a summary of the findings.

2. Strategic Context

2.1 Policy Documents

Scottish Government Economic Strategy

2.1.1 In March 2022, the Scottish Government published its National Strategy for Economic Transformation (Scottish Government, 2022). The ten-year strategy provides a set of key priorities and actions with a vision of achieving a wellbeing economy that is prosperous for all of the country's people and places. A wellbeing economy is one that delivers economic prosperity across social, economic, and environmental dimensions. This includes capitalising on Scotland's most advantageous economic opportunities such as the transition to a net zero economy and a green recovery from the COVID-19 pandemic. Additionally, it includes reducing the socio-economic inequalities that exist between parts of the country.

2.1.2 The ambition of the strategy is for ‘Scotland to be successful’ over the next decade. This includes creating an economy in which all people can have access to skilled, well-paid, jobs, and businesses and entrepreneurs have the conditions necessary to flourish.

2.1.3 To deliver its vision and address these challenges, five programmes of action have been identified (with a sixth priority of creating a culture of delivery), including:

- entrepreneurial people and culture: establishing Scotland as a world-class entrepreneurial nation;
- new market opportunities: strengthening Scotland's position in new markets and industries, generating new, well-paid jobs from a just transition to net zero;
- productive businesses and regions: making Scotland's businesses, industries, regions, communities and public services more productive and innovative;
- skilled workforce: ensuring that people have the skills they need to meet the demands of the economy, and that employers invest in their skilled employees;
- a fairer and more equal society: reorienting the economy towards wellbeing and fair work.

2.1.4 The Proposed Project will contribute in particular to the programmes of action related to new market opportunities and to productive businesses and regions, as well as indirectly contributing to all of the other programmes.

Greener, Fairer Scotland – Programme for Government 2023-2024

2.1.5 This strategy builds on the Scottish Government’s Programme for Government 2021-22 (Scottish Government, 2021), which set out the strategic aims and ambitions for a ‘fairer, greener Scotland’ over a parliamentary term, and highlighted the longer term priorities of the Scottish Government (and so provide relevant context beyond the 2021-22 parliamentary term).

2.1.6 The space sector is specifically mentioned in the Programme for Government 2021-22: “One sector which offers significant potential is the space sector. We will support Scotland to become a leading European space nation by working with industry to deliver a full end to end solution for satellite design, manufacture and testing, launch and data exploitation, targeting a £4 billion share of the global space market. One step will be the development of a joint Scottish Government, industry and academia strategy for sector growth, to be launched in October 2021, and delivery of a dedicated launch capability by summer 2023, targeting a £4 billion share of the global space market, with 20,000 jobs in the sector by 2030.”

2.1.7 In addition to its potential economic contribution, there are wider benefits from the operations of the sector. For example, the data collected from space support the tracking of climate variables, with 35 of the 45 essential climate variables that are set out by the UN relying on measurement from space. Satellite data have also either an important or supportive role in the monitoring of the UN's Sustainable Development Goals, which underpin its efforts to eradicate poverty and hunger across the world by 2030 (McKee, 2020).

Prosperity from Space

2.1.8 In 2018, the Space Growth Partnership, an industry group that brings together companies, academics, institutions and entrepreneurs involved in the space sector, published Prosperity from Space (Space Growth Partnership, 2018).

2.1.9 At the core of the strategy are four pillars:

- creating a National Space Programme to unlock increased private investment;
- creating the right environment for success by securing and building on existing strengths and market position;
- investing in people and places; and,
- continuing to drive growth from investment in ESA, Eumetsat and EU programmes.

2.1.10 The Proposed Project contributes towards addressing the need to maximise the value generated by UK spaceports and launch activities, one of four market priorities identified in the strategy, and to spread the benefits from the space sector across the UK.

Shetland Islands Council Economic Development Strategy

2.1.11 In 2018, Shetland Islands Council published its economic development strategy to 2022 (Shetland Islands Council, 2018a). The document provides a baseline of the Shetland economy, highlighting its strengths as well as some of the challenges it faces, including a declining population, underemployment, pressure on public services and Brexit.

2.1.12 The mission underpinning the strategy is to: "enable and promote the ideal conditions for growth and to support our businesses, residents and communities to take advantage of the opportunities this will create." In order to fulfil this mission, the Economic Development Strategy sets outs six actions:

- to encourage private sector growth, diversification and development;
- to increase economic participation;
- to match economic development to skills and research and development;
- to ensure the representation of Shetland interests at national, regional and external level;
- to increase the attractiveness of Shetland as a place where to study, live and work; and,
- to increase the rate of innovation and adoption of new technologies.

Scotland's Outlook 2030

2.1.13 Following on from the Tourism Scotland 2020 strategy (Scottish Tourism Alliance, 2012), a collaborative network of industry experts created Scotland's Outlook 2030 (Scottish Tourism Alliance, 2020), which focuses on creating a world-leading tourism sector in Scotland that is sustainable in the long-term.

2.1.14 The strategy focuses on four key priorities: people, places, businesses and experiences. The strategy recognises the effects of climate change, technological advancements, Brexit and changing consumer behaviour on tourism and highlights the need for collaboration between government, communities and the public and private sectors.

Shetland's Tourism Strategy

2.1.15 The Shetland Tourism Strategy 2018-2023 (Shetland Tourism Association, 2018) was developed by a range of organisations with a stake in the development of the tourism sector in the Shetland Islands. These include Shetland Tourism Association, Shetland Islands Council, Visit Scotland, Highlands and Islands Enterprise, Lerwick Port Authority, Shetland Arts Development Agency and Shetland Amenity Trust.

2.1.16 The strategy is aligned with both the Tourism Scotland 2020 strategy (Scottish Tourism Alliance, 2012) and with three of the four priorities identified in the Shetland's Partnership Plan 2018-2028 (Various, 2018): participation, place and money.

2.1.17 The document identifies seasonality and constraints to capacity from air and boat services as two challenges for the tourism sector in the Shetland Islands. In particular, despite an increase in events throughout the year including Wool Week, tourism remains for the most part confined to the summer months.

2.1.18 The aim of the strategy is to: "help make Shetland a year-round, sustainable tourism destination offering unique and outstanding visitor experiences." To achieve this, three priority areas have been identified: leadership and collaboration, exploiting opportunities and enhancing visitor experience.

2.1.19 The Proposed Project could diversify the portfolio of visitor attractions that the Shetland Islands can offer. The fact that launches would take place throughout most of the year may also allow businesses in the tourism sector to benefit from visits outwith the summer months.

Local Development Plan

2.1.20 Socio-economic considerations feature prominently in the Shetland Local Development Plan. The foreword notes that: "The Shetland Local Development Plan sets out the Council's vision and spatial strategy that recognises existing development and promotes sustainable growth. The strategy is supported by a framework for delivery that will: promote economic growth; result in sustainably located and planned housing; support appropriate transport and infrastructure planning; and conserve and protect biodiversity and the natural environment."

2.1.21 More specifically, GP1 Sustainable Development states that: “Development will be planned to meet the economic and social needs of Shetland…” and that is justified on the basis that: “Enabling sustainable development requires coordinated action, combining economic competitiveness and social inclusion with environmental quality.”

2.1.22 The Economic Development policies include ED1 Support for Business and Industry which states that: “The Council encourages the creation of sustainable economic development opportunities and business developments in accordance with General Policies”.

3. Assessment Methodology

3.1 Environmental Zone of Influence

3.1.1 The population and economic study areas considered in this assessment are:

- Unst;
- The Shetland Islands; and,
- Scotland.

3.2 Assessment of Socio-Economic Benefits

3.2.1 The assessment of socio-economic benefits from operation of the Proposed Project follows the guidance and methodology set out in the ‘Draft Advice on Net Economic Benefit and Planning’ (Scottish Government, 2016). As a result, all the economic impacts considered are net of those benefits that would occur if the project did not go ahead.

3.2.2 The methodology has been complemented by BiGGAR Economics’ experience on estimating the economic impacts from other projects and by its understanding of the local economy. The methodology was used for the assessment of population effects in the SaxaVord Spaceport AEE Report.

3.2.3 The analysis of economic impacts relies on two commonly used measures:

- Gross Value Added (GVA), a measure of the value that an organisation, company or industry adds to the economy through its operations. The analysis uses the production approach to measure this contribution, where the GVA is equal to the value of production less the value of the inputs used; and,
- Employment, which is measured in terms of headcount jobs supported when considering operational impacts.

3.2.4 For this assessment, the following sources of economic impact from operation of the Proposed Project have been identified:

- the employment supported by the contribution of the Proposed Project to the operations of SaxaVord Spaceport;

- temporary workers' spending on accommodation and subsistence; and,
- the spending of visitors viewing the launches.

3.2.5 The analysis relies on data from publicly available statistics and previous experience. Where assumptions have been made throughout the analysis, these have been set out clearly and justified.

3.2.6 To estimate the impacts associated with the Proposed Project, the value of contracts carried out or the employment supported by them has been estimated. The approach used to estimate the spending associated with tourism is slightly different, as the total number of visitors was estimated based on the maximum tourism capacity allowed by existing accommodation provision and links to the rest of the Shetland Islands. Turnover from tourism has been estimated by multiplying the total number of visitors by the average spending of visitors to the Shetland Islands.

3.2.7 Once total turnover or employment are estimated, economic activity is allocated to the economic sectors where it occurred based on the Office for National Statistics' (ONS) Standard Industrial Classification (SIC) codes (Office for National Statistics, 2009). In a similar way, spending and employment were allocated to the areas where they occurred.

3.2.8 The estimation of the direct GVA and employment supported by expenditure on project-related contracts and activities relied on applying sectoral level turnover per GVA, turnover per job or GVA per job ratios sourced from the Scottish Annual Business Statistics (SABS) (Scottish Government, 2019b).

3.2.9 Alongside direct GVA and employment impacts, the analysis considered indirect and induced economic impacts. Indirect impacts result from the spending taking place within the supply chains of those businesses that are awarded contracts related to the operation of the Proposed Project. Induced impacts refer to the benefits arising from the spending of salaries and wages by those employed in businesses carrying out contracts associated with the Proposed Project.

3.2.10 Indirect and induced impacts were estimated by applying the relevant Scottish GVA and employment Type 1 and Type 2 multipliers, as sourced from the Scottish Government 2016 Input-Output Tables (Scottish Government, 2019c).

3.2.11 In estimating net economic benefits, the analysis followed the guidance on additionality as set out in the Homes and Communities' Agency "Additionality Guide" (Homes & Communities Agency, 2014) and discounted impacts based on:

- leakage – any economic impacts benefitting those from outside the study area where a project takes place;
- displacement – any benefits to the area where the project takes place that are accounted for reduced activity in another geographical area; and,
- deadweight – any outcomes and benefits that are expected to arise if the project did not go ahead.

3.2.12 The assessment also includes consideration of wider economic benefits arising from the Proposed Project. These were not quantified but were described as part of the analysis.

3.3 Assessment of Potential Effect Significance

3.3.1 The assessment follows the evaluation methodology used in similar environmental impact assessments. This assesses the significance of a change in socio-economic conditions based on the sensitivity of the receptor and the magnitude of impact.

3.3.2 The following aspects were considered when appraising the sensitivity to changes in socio-economic conditions:

- the scale of the economy affected;
- its relative fragility; and,
- the diversification of its economic base.

3.3.3 For instance, an area with smaller economic activity is more sensitive to a change in employment than a relatively larger economic area. Equally, an economic area where activity is concentrated in one economic sector is more sensitive to the emergence of opportunities in another sector than an economy with a diversified economic base.

3.3.4 The magnitude of impacts is considered as follows:

- major if the project leads to a 4% change in economic activity, which is more than double the average annual rate of growth for the Scottish economy;
- moderate if the project leads to a change in economic activity of 2%, which is higher than the average annual rate of growth for the Scottish economy;
- minor if the project leads to a 1% change in economic activity; and,
- negligible if the project leads to an increase in economic activity of less than 0.1%.

3.3.5 The significance of changes is then assessed based on sensitivity and magnitude and professional judgement. The significance of effects is described below. In terms of assessment of environmental effect under the Space Industry Act 2018, major and moderate impacts are to be considered to result in significant effects.

3.4 Limitations to Assessment

3.4.1 Since there are no other data from operational spaceports located in the UK or across Europe, it is not possible to rely on any evaluation carried out on the impacts from a similar project in an equivalent socio-economic environment.

4. Baseline Conditions

4.1 Historic Economic Context

4.1.1 The population of Unst has declined significantly over the last century to an estimated level of around 700 people and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands. Within the context of the wider SaxaVord Spaceport, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Islands.

4.2 Economic Baseline

4.2.1 The SaxaVord Spaceport AEE Report described the baseline conditions, and this remains relevant for the Proposed Project. The main findings of the baseline assessment are summarised in this section.

4.2.2 In 2019, the population of the Shetland Islands was 22,920, around 0.4% of Scotland's total population and the population of Unst is estimated to be around 700 people. By 2043 the population of the Shetland Islands is expected to decline to 21,579, a decrease of around 6% on the 2018 population. In comparison, the population of Scotland is expected to increase by 2.5% over the same period.

4.2.3 The 2019 economic activity rate in the Shetland Islands was 3.3% higher than for Scotland overall. Similarly, the 2019 unemployment rate for the Shetland Islands was 2% lower than the average for Scotland and the median annual pay of full-time workers in the Shetland Islands was higher than across Scotland as a whole.

4.2.4 in 2017 the mean income in the North Isles of Shetland (which include Unst) was £31,364, the lowest among the other areas of the Shetland Islands considered. The mean income of the lower quartile was also smaller in the North Isles (£15,256) than across other areas in the Shetland Islands.

4.2.5 In 2018, there were an estimated 220 people in employment in Unst and 16,000 for the Shetland Islands as a whole. Agriculture, forestry and fishing were the main employers in the Shetland Islands, accounting for 18.8% of total employment. Health and social care (14.1%) and wholesale and retail trade (10.2%) were other relatively important sectors in terms of employment. However, in the North and East Isles of the Shetland Islands (including Unst), manufacturing was a large source of employment, accounting for 18.2%, compared to 5.9% for the Shetland Islands as a whole and 6.9% for Scotland. Employment in the accommodation and food service sector was lower in the North and East Isles (2.2%) than for the Shetland Islands (6.2%) and the Scottish average (7.9%)

4.2.6 Sustainable tourism is one of six sectors identified by the Scottish Government as comprising those industries where Scotland has a relative advantage. The sector has a similar weight in the economies of the Shetland Islands and Scotland supporting around 8% of total employment.

4.2.7 Over the period between May 2019 and March 2020, over 130,000 passengers used the ferry service serving Unst, Yell and Fetlar and a total 18,085 journeys were completed (Shetland Islands Council, 2020). The busiest months were those during the summer period and coincided with when the tourism season is at its peak.

4.2.8 There are a number of existing accommodation providers in Unst, ranging from hotels to self-catered cottages and hostels. Primarily these services are available during the summer season (April through to October) however, some smaller self-catered accommodation providers also operate on a restricted basis during the winter months. In total (in season), they can provide accommodation for approximately 230 visitors (Visit Unst, 2020a).

4.2.9 The Proposed Project, as part of the wider SaxaVord Spaceport initiative, provides an opportunity for Unst to diversify its offer to visitors by including space tourism to its attractions' portfolio. It may also result in visitors that would have already come to the island for other reasons, including its scenery or its heritage and history, to spend more time on Unst.

4.2.10 The Proposed Project is also expected to lead to an increase in business tourism, as the launches will require staff to be on-site for a minimum of four weeks per launch campaign.

4.2.11 The increase in activity will provide existing businesses with opportunities to fill their offer of rooms. This may also lead to an extension of the tourism season to take advantage from the opportunities associated with launches as well as to expand existing provision.

5. Potential Effects: Proposed Project

5.1.1 During operation of the Proposed Project, beneficial economic impacts are expected to arise from three main sources:

- employment associated with operation of the Proposed Project;
- accommodation for temporary workers during launches; and,
- space tourism activity.

Employment Associated with Operation of the Proposed Project

5.1.2 SaxaVord Spaceport will support 98 jobs; 63 are expected to be based in Unst and 35 elsewhere within the Shetland Islands. The Proposed Project accounts for one-third of the launch activity of SaxaVord Spaceport and therefore it is reasonable to attribute one-third of the employment to the Proposed Project.

5.1.3 To estimate the GVA associated operation of the Proposed Project, anticipated job numbers have been multiplied by the relevant sectoral GVA per job, based on Scottish Annual Business Statistics and a study on the UK space sector, “Size and Health of the UK Space Industry 2018” (London Economics, 2019).

5.1.4 Supply chain impacts have been estimated by applying the relevant Scottish Type 1 GVA and employment multipliers from the Scottish Input-Output Tables (Scottish Government, 2019c) to the GVA and employment estimated above.

5.1.5 The impact from the spending of salaries and wages created by the operation of the Proposed Project has been estimated using data on the gross/net salary per job from the Scottish Annual Business Statistics the London Economics report. It has been assumed that residents in Unst spend 30% of their salaries in Unst, 50% in the Shetland Islands (including Unst) and 70% in Scotland (including the Shetland Islands). Likewise, residents of the Shetland Islands were estimated to spend 5% of their salaries in Unst, 50% in the Shetland Islands and 70% in Scotland. Impacts from workers’ expenditure was then estimated based on the ratios and multipliers of the household spending sector.

5.1.6 Summing these elements together, it is estimated employment associated with operation of the Proposed Project will generate £1.1 million GVA and support 23 jobs in Unst. For the Shetland Islands this increases to £1.8 million GVA and 40 jobs, and for Scotland, £2.1 million GVA and 46 jobs as shown in Table 1 below.

Table 1 Economic Impact - Employment associated with the Proposed Project

	Unst	Shetland Islands	Scotland
Employment	23	40	46
GVA (£m)	1.1	1.8	2.1

5.1.7 The effect associated with employment is therefore assessed as:

- major beneficial (significant effect) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

Accommodation for Temporary Workers during Launches

5.1.8 Launch staff will need to be accommodated locally during preparation and decommissioning works prior to each launch. It is envisaged that some staff may also be permanently located in Unst.

5.1.9 The Applicant will pay for the maintenance (accommodation and food) of their staff while in Unst. This spending in turn will benefit local accommodation providers supporting their turnover and employment.

5.1.10 SaxaVord Spaceport anticipates that approximately 50 launch staff will be stationed in Unst for around four weeks during any launch campaign. By multiplying staff days required by 10 launches per year it is estimated that launch staff workers will stay in Unst for 14,000 days per year.

5.1.11 Given the existing accommodation capacity in Unst and the available data on average occupancy rates for the Shetland Islands from the 2019 Scottish Accommodation Occupancy Survey (Moffat Centre et al., 2020), workers are unlikely to displace any other users of accommodation facilities in Unst. As a result, all of this impact is considered as additional.

5.1.12 Maintenance expenditure associated with these stays has been assumed to amount to an average of £50 per worker per day and, on this basis, spending on accommodation will amount to around £0.7 million, discounted by 8% to account for spending on VAT.

5.1.13 By applying the turnover per GVA ratio from the Accommodation and Food Services activities from Scottish Annual Business Statistics, direct GVA and employment supported by this spending has been calculated. Supply chain impacts and income effects have been estimated by applying relevant Type 1 and Type 2 Scottish multipliers, as done in previous sections.

5.1.14 It is estimated that spending on food and accommodation from the temporary launch workers will generate £0.4 million GVA and support 18 jobs in Unst. For the Shetland Islands this increases to £0.5 million GVA and 20 jobs, and for Scotland £0.5 million GVA and 21 jobs as shown in Table 2 below.

Table 2 Economic Impact – Accommodation Spending

	Unst	Shetland Islands	Scotland
Employment	18	20	21
GVA (£m)	0.4	0.5	0.5

Tourism Activity

5.1.15 Launches are anticipated to attract visitors to Unst and the Shetland Islands. Visitor spending will have economic benefits, supporting local businesses and increasing employment in the tourism sector.

5.1.16 The level of impact from tourism is based on the total number of visitors that are able to view any given launch. This will be constrained by the number of overnight stays available in Unst and by the capacity of the ferry links to carry visitors for day trips.

5.1.17 As set out previously, it is estimated that Unst has capacity for up to 230 overnight stays. However, 50 of these will be taken up by launch staff as described in the previous section. In addition, approximately 20 of the visitors are anticipated to be senior staff from SaxaVord Spaceport and the Applicant. Consequently, it has been assumed that there will be capacity to accommodate 160 visitors overnight per launch.

5.1.18 Ferry capacity for day trips has been estimated using data from Shetland Islands Council, which states that the monthly peak number of passengers on the ferry to Unst, Yell and Fetlar in 2019 was 20,381. (Shetland Islands Council, 2020). This equates to a daily maximum of around 657 people per day. As day visitors must also travel home following the launch, the maximum number of day visitors has been estimated as 329. In total, it is estimated that a maximum of 489 visitors will be able to view any given launch.

5.1.19 With 10 launches per year, it is estimated that 3,922 visitors will view the launches.

5.1.20 Not all tourism activity can be considered as additional. Given the constraints in accommodation and ferry capacity, some visitors may displace other tourists that would have otherwise visited Unst for other reasons. As a result, it has been assumed that around 90% of tourism activity will be additional with respect to Unst, 80% with respect to the Shetland Islands and 50% with respect to Scotland.

5.1.21 It has been assumed that overnight visitors will spend on average £448 during their stay in the Shetland Islands (Shetland Islands Council, 2018). In terms of the Scottish economy, predicted spend is higher at £726 per visit and takes into account of travelling costs to reach the Shetland Islands. It has been assumed that day visitors to Unst will spend on average £36 on the island. These visitors are considered as overnight visitors from the perspective of their spending in the Shetland Islands and in Scotland. Tourism spending has been discounted by 8% to account for VAT, which is not included in the ratios from the UK Input-Output tables and multipliers.

5.1.22 Direct GVA and employment have been estimated by applying the turnover per GVA and turnover per job ratios for the Tourism sector, constructed using a series of industrial sector codes linked to accommodation, food and beverage and leisure activities. Indirect and induced impacts were then estimated making use of Scottish GVA and employment Type 1 and Type 2 multipliers.

5.1.23 It is estimated that tourism due to the Proposed Project will generate £0.1 million GVA and support 6 jobs in Unst. For the Shetland Islands this increases to £0.3 million GVA and 10 jobs, and for Scotland £0.8 million GVA and 18 jobs as shown in Table 3.

Table 3 Tourism Impact

	Unst	Shetland Islands	Scotland
Employment	6	10	18
GVA (£m)	0.1	0.3	0.5

5.1.24 The effect from tourism activity related to the Proposed Project is assessed as being:

- moderate beneficial (significant effect) for Unst; and,
- negligible for The Shetland Islands and Scotland.

Summary

5.1.25 Summing the beneficial effects resulting from employment associated with the operation of the Proposed Project, accommodation for temporary workers during launches and space tourism activity, as detailed in Table 4 below, it is considered that the Proposed Project will generate:

- £1.6 million GVA and 47 jobs in Unst (representing a substantial increase in employment);
- £2.6 million GVA and 70 jobs across the Shetland Islands; and,
- £3.1 million GVA and 85 jobs across Scotland.

Table 4 Total Economic Impact from operation of Proposed Project

	Unst	Shetland Islands	Scotland
Employment	47	70	85
GVA (£m)	1.6	2.6	3.1

5.1.26 The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (significant effect) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

5.1.27 In addition, the Proposed Project, as part of the wider SaxaVord Spaceport initiative, will result in a series of wider, less quantifiable, benefits for the economies of Unst, the Shetland Islands and Scotland including:

- Making Scotland more competitive in the small satellite space sector. This would complement the activities already carried out in the sector in Scotland and would mean that Scotland could offer the whole supply-chain for the small satellite sector.
- Diversifying the economic base of Unst and the Shetland Islands towards the space sector and away from the oil and gas industry, on which it currently relies heavily and is noted to be in decline. This diversification of the economic base may lead to an increase of the local economy's resilience.
- Offering a wider range of employment opportunities and new career paths available to young people in Unst and in the Shetland Islands.
- Acting as a catalyst for further investment.
- Encouraging investment in the tourism sector, as launches extend the tourism season and provide additional visitors to Unst and to the Shetland Islands with another reason to spend time there.

6. Cumulative Assessment

6.1.1 SaxaVord Spaceport has a proposed capacity for 30 launches per annum. The Proposed Project will account for 10 of those launches.

6.1.2 Assuming operators are identified for the remaining capacity, the cumulative socio-economic benefits of all 30 launches would be expected to be approximately triple the benefits identified in the assessment above, as documented in the SaxaVord Spaceport AEE:

6.1.3 'Full operation of the [SaxaVord Spaceport] will see a maximum of 30 launch events per year. During operation, beneficial economic impacts are expected to arise from three main sources:

- *employment associated with operation of the Proposed Project;*
- *accommodation for temporary workers during launches; and,*
- *space tourism activity.*

6.1.4 It is estimated that employment associated with this level of activity will generate:

- *£3.3 million GVA and support 68 jobs in Unst;*
- *£5.3 million GVA and support 119 jobs in The Shetland Islands; and,*
- *£6.2 million GVA and support 137 jobs across Scotland.*

6.1.5 Spending on accommodation for temporary workers during launches is estimated to generate:

- *£1.2 million GVA and support 55 jobs in Unst;*
- *£1.4 million GVA and support 59 jobs in The Shetland Islands; and,*
- *£1.6 million GVA and support 64 jobs across Scotland.*

6.1.6 Spending by visitors coming to Unst for space tourism is estimated to generate:

- *£0.4 million GVA and support 17 jobs in Unst;*
- *£0.8 million GVA and support 30 jobs in The Shetland Islands; and,*
- *£1.5 million GVA and support 54 jobs across Scotland.*

6.1.7 Summing all these impacts together, it is estimated that the total impact from operation of the Proposed Project will be:

- *£4.9 million GVA and 139 jobs in Unst;*
- *£7.5 million GVA and 209 jobs in The Shetland Islands; and,*
- *£9.3 million GVA and 255 jobs in Scotland.'*

6.1.8 Additionally, if the Proposed Project, as part of the wider Spaceport development, were to stimulate investment (for example, to provide additional visitor accommodation for those working on or viewing launches) or new entrepreneurial activity to take advantage of the supply chain opportunities that are expected to arise, this would increase the economic impacts in the Unst and Shetland Islands economies.

7. Summary

7.1.1 This appendix has considered impacts associated with operation of the Proposed Project and how these fit into the local and national economic context.

7.1.2 The population of Unst has declined significantly over the last century to an estimated level of around 700 people and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands.

7.1.3 Within the context of the wider SaxaVord Spaceport, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Isles and will generate significant beneficial local effects through:

- employment associated with operation of the Proposed Project;
- demand for goods and services to support the operation of the Proposed Project;
- hosting temporary workers and staff from the Applicant who will then utilise local shops, hospitality and other amenities; and,
- attracting tourists who will visit to watch launches and/or explore SaxaVord Spaceport (including outside the current summer tourism season).

7.1.4 The predicted economic effects are considered to be major beneficial (significant) locally.

7.1.5 Full operation of the Proposed Project will see a maximum of 10 launches of the Orbex PRIME Launch Vehicle per year.

7.1.6 It is estimated that employment associated with operational activities of the launches will generate:

- £1.1 million GVA and support 23 jobs in Unst;
- £1.8 million GVA and support 40 jobs in The Shetland Islands; and,
- £2.1 million GVA and support 46 jobs across Scotland.

7.1.7 Spending on accommodation for temporary workers during launches is estimated to generate:

- £0.4 million GVA and support 18 jobs in Unst;
- £0.5 million GVA and support 20 jobs in The Shetland Islands; and,
- £0.5 million GVA and support 21 jobs across Scotland.

7.1.8 Spending by visitors coming to Unst for space tourism is estimated to generate:

- £0.1 million GVA and support 6 jobs in Unst;
- £0.3 million GVA and support 10 jobs in The Shetland Islands; and,
- £0.5 million GVA and support 18 jobs across Scotland.

7.1.9 Summing all these impacts together, it is estimated that the total impact from operation of the Proposed Project will be:

- £1.6 million GVA and 47 jobs in Unst;
- £2.6 million GVA and 70 jobs in The Shetland Islands; and,
- £3.1 million GVA and 85 jobs in Scotland.

7.1.10 The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (significant) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

7.1.11 In addition, the Proposed Project, as part of the wider SaxaVord Spaceport initiative, is also expected to result in a series of wider, less quantifiable, benefits for the economies of Unst, the Shetland Islands and Scotland including:

- Making Scotland more competitive in the small satellite space sector, by contributing to the development and success of SaxaVord Spaceport.
- Diversifying the economic base of Unst and the Shetland Islands towards the space sector.
- Offering a wider range of employment opportunities and new career paths available to young people in Unst and in the Shetland Islands.
- Acting as a catalyst for further investment; and,
- Encouraging investment in the tourism sector, as launches extend the tourism season and provide additional visitors to Unst and to the Shetland Islands.

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Appendix 2.5 SaxaVord Spaceport AEE Population and Human Health Chapter

CHAPTER 4 POPULATION AND HUMAN HEALTH

4. Population and Human Health

4. Population and Human Health

4.1 Introduction

4.1.1 Effects on Human Health from the Proposed Project are discussed in detail in the relevant technical chapters of this AEE Report - Air Quality (Chapter 7) and Noise (Chapter 8) and a summary of the findings presented in this Chapter for information.

4.1.2 This chapter sets out the effects of the Proposed Project on population and human health, and in particular focuses on the socio-economic effects including the economic impacts associated with its operation.

4.1.3 The population of Unst has declined significantly over the last century to an estimated level of around 700 people and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands. In this context, the Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Isles.

4.1.4 This chapter is structured as follows:

- Section 4.2 sets out relevant legislation, policy and guidelines;
- Section 4.3 summarises the effects of the Proposed Project on human health;
- Section 4.4 describes the assessment methodology and significance criteria for other effects on population;
- Section 4.5 considers the baseline socio-economic and tourism conditions;
- Section 4.6 lists the receptors brought forward for assessment;
- Section 4.7 assesses potential effects;
- Section 4.8 considers any mitigation required;
- Section 4.9 assesses residual effects;
- Section 4.10 describes any cumulative impacts; and,
- Section 4.11 provides a summary of the chapter's findings.

4.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

4.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;

- operate a spaceport in the UK; or
- provide range control services from the UK.

Policy Documents

4.2.2 Whilst there is no policy specific to the assessment of the economic impacts of space ports, given the Proposed Project's characteristics, it is possible to follow existing guidance on the economic impacts from the planning regime. The economic analysis therefore follows the guidance set out in the Scottish Government's Draft Advice on Net Economic Benefit and Planning (Scottish Government, 2016).

Scottish Government Economic Strategy

4.2.3 In 2015 the Scottish Government published the Scottish Government Economic Strategy (Scottish Government, 2015). In order to make Scotland a more successful country over a range of dimensions, the strategy has at its core increasing sustainable economic growth. This relies on simultaneously boosting competitiveness and reducing inequality.

4.2.4 Four themes have been identified as key to generating sustainable economic growth: internationalisation, innovation, inclusive growth and investment.

4.2.5 The innovation and high-value activities carried out by the space sector, the potential to attract investment and international companies in the small satellite sector and, the possibility to support local economic growth, are all in line with the four themes identified in the Scottish Government's Economic Strategy.

4.2.6 In the summer of 2021, the Scottish Government established a new Advisory Council to develop a new 10 year national strategy for economic transformation. Whilst that has not yet been published the Scottish Government's priorities can be seen in the Programme for Government.

A Fairer, Greener Scotland – Programme for Government 2021-22

4.2.7 The Scottish Government's Programme for Government 2021-22 (Scottish Government, 2021) sets out the strategic aims and ambitions for a 'fairer, greener Scotland' over the next parliamentary term, and also the longer term priorities of the Scottish Government.

4.2.8 The space sector is specifically mentioned in the Programme for Government: "*One sector which offers significant potential is the space sector. We will support Scotland to become a leading European space nation by working with industry to deliver a full end to end solution for satellite design, manufacture and testing, launch and data exploitation, targeting a £4 billion share of the global space market. One step will be the development of a joint Scottish Government, industry and academia strategy for sector growth, to be launched in October 2021, and delivery of a dedicated launch capability by summer 2023, targeting a £4 billion share of the global space market, with 20,000 jobs in the sector by 2030.*"

4.2.9 In addition to its potential economic contribution, there are wider benefits from the operations of the sector. For example, the data collected from space support the tracking of climate variables, with 35 of the 45 essential climate variables that are set out by the UN relying on measurement from space. Satellite data have also either an important or supportive role in the monitoring of the UN's Sustainable Development Goals, which underpin its efforts to eradicate poverty and hunger across the world by 2030 (McKee, 2020).

Prosperity from Space

4.2.10 In 2018, the Space Growth Partnership, an industry group that brings together companies, academics, institutions and entrepreneurs involved in the space sector, published Prosperity from Space (Space Growth Partnership, 2018).

4.2.11 At the core of the strategy are four pillars:

- creating a National Space Programme to unlock increased private investment;
- creating the right environment for success by securing and building on existing strengths and market position;
- investing in people and places; and,
- continuing to drive growth from investment in ESA, Eumetsat and EU programmes.

4.2.12 The Proposed Project contributes towards addressing the need to maximise the value generated by UK space ports and launch activities, one of four market priorities identified in the strategy, and to spread the benefits from the space sector across the UK.

Shetland Islands Council Economic Development Strategy, 2018-2022

4.2.13 In 2018, Shetland Islands Council published its economic development strategy to 2022 (Shetland Islands Council, 2018a). The document provides a baseline of the Shetland economy, highlighting its strengths as well as some of the challenges it faces, including a declining population, underemployment, pressure on public services and Brexit.

4.2.14 The mission underpinning the strategy is to: *"enable and promote the ideal conditions for growth and to support our businesses, residents and communities to take advantage of the opportunities this will create"*. In order to fulfil this mission, the Economic Development Strategy sets outs six actions:

- to encourage private sector growth, diversification and development;
- to increase economic participation;
- to match economic development to skills and research and development;
- to ensure the representation of Shetland interests at national, regional and external level;
- to increase the attractiveness of Shetland as a place where to study, live and work; and,
- to increase the rate of innovation and adoption of new technologies.

Scotland's Outlook 2030

4.2.15 Following on from the Tourism Scotland 2020 strategy (Scottish Tourism Alliance, 2012), a collaborative network of industry experts created Scotland's Outlook 2030 (Scottish Tourism Alliance, 2020), which focuses on creating a world-leading tourism sector in Scotland that is sustainable in the long-term.

4.2.16 The strategy focuses on four key priorities: people, places, businesses and experiences. The strategy recognises the effects of climate change, technological advancements, Brexit and changing consumer behaviour on tourism and highlights the need for collaboration between government, communities and the public and private sectors.

Shetland Tourism Strategy, 2018-2023

4.2.17 The Shetland Tourism Strategy 2018-2023 (Shetland Tourism Association, 2018) was developed by a range of organisations with a stake in the development of the tourism sector in the Shetland Islands. These include Shetland Tourism Association, Shetland Islands Council, Visit Scotland, Highlands and Islands Enterprise, Lerwick Port Authority, Shetland Arts Development Agency and Shetland Amenity Trust.

4.2.18 The strategy is aligned with both the Tourism Scotland 2020 strategy (Scottish Tourism Alliance, 2012) and with three of the four priorities identified in the Shetland's Partnership Plan 2018-2028 (Various, 2018): participation, place and money.

4.2.19 The document identifies seasonality and constraints to capacity from air and boat services as two challenges for the tourism sector in the Shetland Islands. In particular, despite an increase in events throughout the year including Wool Week, tourism remains for the most part confined to the summer months.

4.2.20 The aim of the strategy is to: "*help make Shetland a year-round, sustainable tourism destination offering unique and outstanding visitor experiences*". To achieve this, three priority areas have been identified: leadership and collaboration, exploiting opportunities and enhancing visitor experience.

4.2.21 The launch activity taking place from the Proposed Project could diversify the portfolio of visitor attractions that the Shetland Islands can offer. The fact that launch activity would take place throughout most of the year may also allow businesses in the tourism sector to benefit from visits outwith the summer months.

Local Development Plan

4.2.22 Socio-economic considerations feature prominently in the Shetland Local Development Plan. The foreword notes that: "*The Shetland Local Development Plan sets out the Council's vision and spatial strategy that recognises existing development and promotes sustainable growth. The strategy is supported by a framework for delivery that will: promote economic growth; result in sustainably located and planned housing; support appropriate transport and infrastructure planning; and, conserve and protect biodiversity and the natural environment.*"

4.2.23 More specifically, GP1 Sustainable Development states that: "*Development will be planned to meet the economic and social needs of Shetland...*" and that is justified on the basis that: "*Enabling sustainable development requires coordinated action, combining economic competitiveness and social inclusion with environmental quality.*"

4.2.24 The Economic Development policies include ED1 Support for Business and Industry which states that: "*The Council encourages the creation of sustainable economic development opportunities and business developments in accordance with General Policies*".

Guidance

Guidance for the Assessment of Environmental Effects

4.2.25 The CAA document "Guidance for the Assessment of Environmental Effects"(July 2021) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act and sets out the environmental topics likely to be affected by the proposed activities.

4.2.26 The Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including population and human health, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- The AEE should explain what other environmental assessments have been conducted in relation to the proposed activities (e.g., EIAs provided as part of a planning application) and whether they are being used in support of the AEE;
- Applicants for a spaceport licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including population and human health.

4.3 Human Health Effects: Summary

4.3.1 Effects on Human Health from the Proposed Project are considered to arise from operational effects on air quality and operational noise effects. These effects are assessed in detail in Chapter 7 and 8 respectively, and as such, a short summary of the findings presented here for information.

Air Quality

4.3.2 An assessment of the potential effects of emissions from the Proposed Project on local air quality has been undertaken.

4.3.3 Proposed project-generated traffic is predicted to have an effect of negligible significance on air quality, therefore resulting in **no likely significant effect.**

4.3.4 Generator emissions are predicted to have no perceptible impact at any identified receptors. The emissions from generators are predicted to have an effect of negligible significance on local air quality, therefore resulting in **no likely significant effect**. Emissions are also expected to reduce over the lifetime of the Proposed Project due to the Applicant's intention to secure a permanent three phase power supply in time.

4.3.5 Launch event emissions are predicted to have no perceptible impact at any identified receptors under prevailing wind directions. The maximum predicted impact at a sensitive receptor is predicted to occur with north-easterly winds, which occur typically for less than 10 % of the year. The maximum predicted 8-hour concentration of CO is 28% of the relevant air quality standard for human health. Emissions from launch events are therefore considered to have an effect of negligible significance on air quality**,** therefore resulting in **no likely significant effect**.

Noise

4.3.6 Potential noise and vibration effects associated with the Proposed Project have been robustly assessed with regard to static engine tests, launches and non-launch activities.

4.3.7 Noise effects associated with road traffic and non-launch activities have been assessed as not significant, resulting in **no likely significant effect**.

4.3.8 Noise during engine tests and launches will be audible at identified noise sensitive receptors and levels will exceed the criterion for community annoyance associated with aircraft noise. However, instantaneous noise levels will be below the threshold at which damage to hearing may occur.

4.3.9 Of the proposed 30 launches per year, when taking into account the no-launch window agreed between mid-May to the end of June, the Applicant anticipates that in any one month there may up to four launches. Given the proposed frequency of launches and the short duration of the noise events associated with launches, and with reference to the 2006 Basner study which states that restricting additional awakenings due to aircraft noise to a maximum of one event per night is anticipated to have no adverse effect on human health, adverse effects associated with sleep disturbance due to night-time launches are considered to be minimal, resulting in **no likely significant effect**.

4.3.10 The short duration of audible noise 'events' associated with engine tests and launches, and their infrequent occurrence, will reduce the associated levels of annoyance to below that which may be associated with aircraft noise from conventional airports. Accordingly, adverse health effects are not anticipated. Noise effects associated with engine tests and launches have therefore been assessed as not significant, resulting in **no likely significant effect**.

4.5 Population Effects: Assessment Methodology and Significance Criteria

Environmental Zone of Influence

4.5.1 The study areas (equivalent to the EZI) considered in the population and human health assessment are:

- Unst;
- The Shetland Islands; and,
- Scotland.

Assessment of Socio-Economic Benefits

4.5.2 The assessment of socio-economic (population) benefits from operation of the Proposed Project follows the guidance and methodology set out in the 'Draft Advice on Net Economic Benefit and Planning' (Scottish Government, 2016). As a result, all the economic impacts considered are net of those benefits that would occur if the project did not go ahead.

4.5.3 The methodology has been complemented by BiGGAR Economics' experience on estimating the economic impacts from other projects and by its understanding of the local economy.

4.5.4 The analysis of economic impacts relies on two commonly used measures:

- Gross Value Added (GVA), a measure of the value that an organisation, company or industry adds to the economy through its operations. The analysis uses the production approach to measure this contribution, where the GVA is equal to the value of production less the value of the inputs used; and,
- Employment, which is measured in terms of headcount jobs supported when considering operational impacts.

4.5.5 For this assessment, the likely sources of economic impact from operation of the Proposed Project have been identified as economic activities linked to the operation of the Proposed Project including:

- the employment supported by the operations of the Proposed Project;
- temporary workers' spending on accommodation and subsistence; and,
- the spending of visitors viewing the launches.

4.5.6 The analysis relied on data from publicly available statistics, on conversations with the Applicant and previous experience. When assumptions were made throughout the analysis, these have been set out clearly and justified.

4.5.7 To estimate the impacts associated with the Proposed Project, the value of contracts carried out or the employment supported by them has been estimated from information given by the Applicant. The approach used to estimate the spending associated with tourism is slightly different, as the total number of visitors was estimated based on the maximum tourism capacity allowed by existing accommodation provision and links to the rest of the Shetland Islands. Turnover from tourism has been estimated by multiplying the total number of visitors by the average spending of visitors to the Shetland Islands.

4.5.8 Once total turnover or employment are estimated, economic activity is allocated to the economic sectors where it occurred based on the Office for National Statistics' (ONS) Standard Industrial Classification (SIC) codes (Office for National Statistics, 2009). In a similar way, spending and employment were allocated to the areas where they occurred.

4.5.9 The estimation of the direct GVA and employment supported by expenditure on project-related contracts and activities relied on applying sectoral level turnover per GVA, turnover per job or GVA per job ratios sourced from the Scottish Annual Business Statistics (SABS) (Scottish Government, 2019b).

4.5.10 Alongside direct GVA and employment impacts, the analysis considered indirect and induced economic impacts. Indirect impacts result from the spending taking place within the supply chains of those businesses that are awarded contracts related to the operation of the Proposed Project. Induced impacts refer to the benefits arising from the spending of salaries and wages by those employed in businesses carrying out contracts associated with the Proposed Project.

4.5.11 Indirect and induced impacts were estimated by applying the relevant Scottish GVA and employment Type 1 and Type 2 multipliers, as sourced from the Scottish Government 2016 Input-Output Tables (Scottish Government, 2019c).

4.5.12 In estimating net economic benefits, the analysis followed the guidance on additionality as set out in the Homes & Communities' Agency "Additionality Guide" (Homes & Communities Agency, 2014) and discounted impacts based on:

- leakage – any economic impacts benefitting those from outside the study area where a project takes place;
- displacement – any benefits to the area where the project takes place that are accounted for reduced activity in another geographical area; and,
- deadweight – any outcomes and benefits that are expected to arise if the project did not go ahead.

4.5.13 The assessment also includes consideration of wider economic benefits arising from the Proposed Project. These were not quantified but were described as part of the analysis.

Assessment of Potential Effect Significance

4.5.14 The assessment follows the evaluation methodology used in similar environmental impact assessments. This assesses the significance of a change in socio-economic conditions based on the sensitivity of the receptor and the magnitude of impact.

4.5.15 The following aspects were considered when appraising the sensitivity to changes in socio-economic conditions:

- the scale of the economy affected;
- its relative fragility; and,
- the diversification of its economic base.

4.5.16 For instance, an area with smaller economic activity is more sensitive to a change in employment than a relatively larger economic area. Equally, an economic area where activity is concentrated in one economic sector is more sensitive to the emergence of opportunities in another sector than an economy with a diversified economic base.

4.5.17 The magnitude of impacts is considered as follows:

- major if the project leads to a 4 % change in economic activity, which is more than double the average annual rate of growth for the Scottish economy;
- moderate if the project leads to a change in economic activity of 2 %, which is higher than the average annual rate of growth for the Scottish economy;
- minor if the project leads to a 1 % change in economic activity; and,
- negligible if the project leads to an increase in economic activity of less than 0.1 %.

4.5.18 The significance of changes is then assessed based on sensitivity and magnitude and professional judgement. The significance of effects is described below. In terms of assessment of environmental effect under the Space Industry Act 2018, major and moderate impacts are to be considered to result in significant effects.

Limitations to Assessment

4.5.19 Since there are no existing satellite space ports located in the UK or across Europe, it is not possible to rely on any evaluation carried out on the impacts from a similar development.

4.6 Population Effects: Baseline Conditions

Economic Context

4.6.1 The population of Unst has declined significantly over the last century to an estimated level of around 700 people and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands.

4.6.2 Much of the economic history of Unst over the last seventy years has been characterised by the presence at Saxa Vord of a Royal Airforce (RAF) base, RAF Saxa Vord. Originally established in 1957 during the Cold War, the base has been an important feature of the Unst economy and has had a relatively strong link with the local community. Through it, the Ministry of Defence (MOD) played an important role as a local employer, alongside supporting jobs across other sectors. Around sixty years after its opening, the base was closed in 2006.

4.6.3 More recently, following incursions on the UK airspace by Russian fighter jets, a radar-based point was re-established. However, no permanent staff are based in Unst, since the radar system is operated remotely.

4.6.4 Since the RAF left the area, there has been an attempt to redirect the local economy. The Proposed Project represents a transformational and much needed economic development opportunity to diversify the local economy and bring investment to Unst.

Socio-Economic Characteristics

4.6.5 Baseline socio-economic characteristics have been determined for three study areas: Unst, The Shetland Islands and Scotland.

4.6.6 Data reflect the most recent evidence available. However, it is recognised that depending on its impact, the COVID 19 pandemic may have temporary or more lasting effects on socio-economic characteristics. Indeed, the space industry is considered likely to play an important role in economic recovery through the high-value jobs it supports and the range of activities it enables. Where data for Unst were not available specifically, information has been reported for the North and East Isles.

Population

4.6.7 In 2019, the population of the Shetland Islands was 22,920, around 0.4 % of Scotland's total population (National Records of Scotland, 2020a). While the National Records of Scotland do not provide population estimates below local authority areas, Visit Unst estimates that the population of Unst is currently around 700 people (Visit Unst, 2020a).

4.6.8 As shown in Table 4.1 below, the Shetland Islands has a slightly larger proportion of the population aged 0-15 than the Scottish average, and the proportion of the population of working age is lower than the Scottish average.

Table 4.1 2019 Population Estimates

	Unst*	Shetland Islands	Scotland
Population	700	22,920	5,463,300
0-15	-	18.3 %	16.9 %
16-64	-	61.2 %	64.0 %
65+	-	20.4 %	19.1 %

Source: (National Records of Scotland, 2020b), (Visit Unst, 2020a)

4.6.9 As shown in Table 4.2, by 2043 the population of the Shetland Islands is expected to decline to 21,579, a decrease of around 6 % on the 2018 population. In comparison, the population of Scotland is expected to increase by 2.5 % over the same period.

4.6.10 The Shetland Islands are also expected to have a smaller proportion (57.1 %) of the population of working age than Scotland (60.3 %) by 2043. Both the populations of the Shetland Islands and Scotland are expected to age over the period to 2043, but the trend is more marked in the Shetland Islands with 27.9 % of the population aged 65 or over - three percentage points higher than for Scotland.

Table 4.2 Population Projections (2018-2043), Shetland Islands and Scotland

	Shetland Islands		Scotland	
	2018	2043	2018	2043
Population	22,990	21,579	5,438,100	5,574,819
0-15	18.3 %	15.1 %	16.9 %	14.8 %
16-64	61.9 %	57.1 %	64.2 %	60.3 %
65+	19.8 %	27.9 %	18.9 %	24.9 %

Source: (National Records of Scotland, 2020a) (National Records of Scotland, 2020b)

4.6.11 In summary, the Shetland Islands has a younger than average population, with a smaller proportion of people of working age than the Scottish average. In addition, the number of people aged 65 or over is projected to increase significantly by 2043.

Economic Activity and Employment

4.6.12 As shown in Table 4.3 below, the 2019 economic activity rate in the Shetland Islands was 3.3 % higher than for Scotland overall. Similarly, the 2019 unemployment rate for the Shetland Islands was 2 % lower than the average for Scotland and the median annual pay of full-time workers in the Shetland Islands was higher than across Scotland as a whole.

Table 4.3 Economic Activity and Earnings (2019)

	Shetland Islands	Scotland
Economic Activity Rate (16-64)	80.8 %	77.5 %
Unemployment Rate (16-64)	1.5 %	3.5 %
Median Annual Pay of Full-time Workers (£)	£31,339	£30,000
% of Full Time Workers	60.8 %	74.7 %
% of Part Time Workers	39.2 %	25.2 %

Source: (Office for National Statistics, 2020a) (Office for National Statistics, 2020b) (Highlands and Islands Enterprise, 2019)

4.6.13 In its publication Shetland in Statistics, Shetland Islands Council collects detailed statistics on a range of subjects including the economy, tourism and demographics. Based on the latest publication (Shetland Islands Council, 2018b), as presented in Table 4.4 below, in 2017 the mean income in the North Isles of Shetland was £31,364, the lowest among the other areas of the Shetland Islands considered. The mean income of the lower quartile was also smaller in the North Isles (£15,256) than across other areas in the Shetland Islands.

Table 4.4 Mean Income and Income of the Lower Quartile - Shetland Islands

	Mean Income	Lower Quartile
Central Mainland	£40,644	£20,430
Lerwick & Bressay	£34,834	£16,473
North Isles	£31,364	£15,256
North Mainland	£36,533	£18,087
South Mainland	£42,477	£21,573
West Mainland	£35,351	£17,765
Whalsay & Skerries	£42,477	£16,704

Source: (Shetland Islands Council, 2018b)

4.6.14 As shown in Table 4.5 below, in 2018 agriculture, forestry and fishing were the main employers in the Shetland Islands, accounting for 18.8 % of total employment. Health and social care (14.1 %) and wholesale and retail trade (10.2 %) were other relatively important sectors in terms of employment.

4.6.15 However, in the North and East Isles of the Shetland Islands (including Unst), manufacturing was a large source of employment, accounting for 18.2 %, compared to 5.9 % for the Shetland Islands as a whole and 6.9 % for Scotland. Employment in the accommodation and food service sector was lower in the North and East Isles (2.2 %) than for the Shetland Islands (6.2 %) and the Scottish average (7.9 %).

Table 4.5 Business Register and Employment Survey, 2018

	North and East Isles	Shetland Islands	Scotland
Agriculture, forestry and fishing*	0.0 %	18.8 %	3.2 %
Mining and quarrying	0.0 %	0.5 %	1.1 %
Manufacturing	18.2 %	5.9 %	6.9 %
Electricity, gas, steam and air conditioning supply	0.0 %	1.0 %	0.7 %

	North and East Isles	Shetland Islands	Scotland
Water supply, sewerage, waste	0.0 %	0.7 %	0.8 %
Construction	2.2 %	8.6 %	5.5 %
Wholesale and retail trade	0.0 %	10.2 %	13.6 %
Transportation and storage	4.4 %	6.2 %	4.2 %
Accommodation and food service activities	2.2 %	6.2 %	7.9 %
Information and communication	0.0 %	1.3 %	3.1 %
Finance and insurance activities	0.0 %	0.2 %	3.4 %
Real estate activities	0.0 %	0.6 %	1.5 %
Professional, scientific and technical activities	4.4 %	3.4 %	7.0 %
Administrative and support service activities	4.4 %	3.8 %	7.9 %
Public administration and defence	6.7 %	5.0 %	6.0 %
Education	20.0 %	7.0 %	7.4 %
Human health and social work activities	22.2 %	14.1 %	15.1 %
Arts, entertainment and recreation	8.8 %	5.6 %	4.8 %
Total Employment	220	16,000	2,611,500

Source: (Office for National Statistics, 2019a) *excludes farm agriculture and includes aquaculture.

4.6.16 According to recent data from Her Majesty's Revenues and Customs (HMRC, 2020a) detailed in Table 4.6 below, by June 2020 at least 3,100 people in the Shetland Islands had been put on furlough due to COVID-19. The recipients of help from the Government support scheme for the self-employed totalled 600 people (HMRC, 2020b). The share of those placed on furlough with respect to the eligible population was higher in Scotland on average (30 %) than in the Shetland Islands (25 %). Similarly, in the Shetland Islands 68 % of those who could benefit from the Self-Employment Support Scheme applied for it, compared to 75 % across Scotland.

Table 4.6 Population on COVID-19 Government Support Scheme

	Shetland Islands		Scotland	
	Value	Eligible (%)	Value	Take-up rate
Coronavirus Job Retention Scheme	3,100	25 %	736,500	30 %
Self-Employment Income Support Scheme	600	68 %	155,000	75 %

Source: (HMRC, 2020a) (HMRC, 2020b)

4.6.17 In summary, economic activity is higher and unemployment is lower in the Shetland Islands when compared to Scotland as a whole. This is complemented by higher wages, though it is noted that part-time work is more prevalent in the Shetland Islands. Across the North Isles (including Unst) however, wages are lower than in other areas of the Shetland Islands.

Qualification Levels

4.6.18 Education qualification levels in the Shetland Islands are significantly lower than in Scotland as a whole as shown in Table 4.7 below. In Scotland, around 45 % of the population had an NVQ4 or equivalent in 2019, whereas in the Shetland Islands this figure was 27.5 %. Conversely, the proportion of the population with no qualifications is lower in the Shetland Islands at 2.6 % compared to 9.8 % for Scotland as a whole.

Table 4.7 Qualification Levels, % of population aged 16-64

	Shetland Islands	Scotland
% with NVQ4+	27.5 %	45.3 %
% with NVQ3+	49.7 %	60.8 %
% with NVQ2+	80.5 %	75.6 %
% with NVQ1+	93.7 %	83.5 %
% with other qualifications (NVQ)	3.7 %	6.7 %
% with no qualifications (NVQ)	2.6 %	9.8 %

Source: (Office for National Statistics, 2020a)

4.6.19 In summary, qualification levels are lower in the Shetland Islands than in Scotland as a whole with a lesser share of the population obtaining university and college level qualifications. The largest employer in the Shetland Islands is agriculture, forestry and fishing, whereas in the North and East Isles (including Unst), manufacturing, health and education are the largest sectors of employment.

Deprivation

4.6.20 According to the 2020 Scottish Index of Multiple Deprivation (Scottish Government, 2020a), which takes account of a wide range of measures of deprivation, none of the 15 % most deprived data zones in Scotland are located in the Shetland Islands. However, in the North and East Isles, geographical access to services scores low and the area is ranked in the most deprived 10 % under this specific indicator.

Tourism Context

4.6.21 Sustainable tourism is one of six sectors identified by the Scottish Government as comprising those industries where Scotland has a relative advantage. As detailed in Table 4.8 below, in 2017/2018, the sustainable tourism sector generated £39.7 million GVA in the Shetland Islands and £4.1 billion GVA in Scotland (Scottish Government, 2020b). In the same year, the sector employed 1,250 people in the Shetland Islands, compared to 218,000 people in Scotland as a whole. The sector has a similar weight in the economies of the Shetland Islands and Scotland supporting around 8 % of total employment.

Table 4.8 Employment and GVA in the Sustainable Tourism Sector

	Shetland Islands	Scotland
Employment	1,250	218,000
GVA (£m)	39.7	4,127.1

Source: (Scottish Government, 2020b)

4.6.22 The most recent evidence on tourism activity within the Shetland Islands comes from the Shetland Visitors Survey 2019 (Shetland Islands Council et al., 2020). In 2019 there were reportedly 80,128 visits to the Shetland Islands, which included visitors spending time in different locations of the Shetland Islands during a single visit.

4.6.23 For 69 % of visitors, the sceneries and landscapes were one of the reasons motivating a visit to the Shetland islands. History, culture and the ability to 'get away from it all' were mentioned by 49 % and 25 % of respondents respectively. Among visitor attractions, those related to history and heritage were the ones visited by tourists in Unst, with 27 % of leisure visitors to the Shetland Islands visiting Unst Heritage Centre & Unst Boat Haven and 21 % Viking Unst.

4.6.24 The survey also considered where visitors spent time while in the Shetland Islands. Visitors tended to spend most of their time in the Mainland of Shetland, with more than 50 % saying that they had visited Lerwick, South Mainland, Central Mainland and West Mainland. In 2019, around 34 % of visitors spent time in Unst, 1 % higher than was recorded in the previous 2017 visitors survey (Shetland Islands Council et al., 2018). Unst was also more popular among leisure visitors – 47 % of whom visited the island – than with those visiting friends and relatives and those coming to the island for business reasons

4.6.25 Whilst the preferred means of transportation for visitors once in the Shetland Islands is hiring a car, intra-island movements take place for the most part by ferry. To reach Unst from the Mainland of Shetland, it is necessary to use the ferry service from Toll (Shetland Mainland) to Ulsta (Yell) and from Gutcher (Yell) to Belmont (Unst). The journey between Lerwick and Unst may take between 90 and 120 minutes (Visit Unst, 2020b).

4.6.26 Over the period between May 2019 and March 2020, over 130,000 passengers used the ferry service serving Unst, Yell and Fetlar and a total 18,085 journeys were completed (Shetland Islands Council, 2020). The busiest months were those during the summer period and coincided with when the tourism season is at its peak.

4.6.27 There are a number of existing accommodation providers in Unst, ranging from hotels to self-catered cottages and hostels. Primarily these services are available during the summer season (April through to October) however, some smaller self-catered accommodation providers also operate on a restricted basis during the winter months. In total (in season), they can provide accommodation for approximately 230 visitors (Visit Unst, 2020a).

4.6.28 The Proposed Project and the launch activity associated with it provide an opportunity for Unst to diversify its offer to visitors by including space tourism to its attractions' portfolio. It may also result in visitors that would have already come to the island for other reasons, including its scenery or its heritage and history, to spend more time on Unst.

4.6.29 The launch activity associated with the Proposed Project is also expected to lead to an increase in business tourism, as the launch activity will require temporary staff from the launch companies to be on-site for a minimum of six weeks per launch event.

4.6.30 The increase in activity will provide existing businesses with opportunities to fill their offer of rooms. This may also lead to an extension of the tourism season to take advantage from the opportunities associated with launch activity as well as to expand existing provision.

4.6.31 In summary, the contribution of the tourism sector in the Shetland Islands economy is proportionately similar to that of Scotland as a whole. Most of the visitors to the Shetland Islands visit the islands to enjoy its naturalistic offer, explore its history and heritage and to unwind.

4.6.32 Unst and the North Isles receive a lower share of tourism than other areas of Shetland. This is partly because of their location, since it may take up to two hours and two ferry crossings to reach Unst from Lerwick. Accommodation providers in Unst can provide overnight accommodation for around 230 visitors and may benefit from the increase in demand associated from the Proposed Project.

4.7 Receptors Brought Forward for Assessment

4.7.1 The following receptors were brought forward for assessment:

- the economy of Unst;
- the economy of The Shetland Islands; and,
- the economy of Scotland.

4.9 Potential Effects

4.9.1 During operation of the Proposed Project, beneficial economic impacts are expected to arise from three main sources:

- employment associated with operation of the Proposed Project;
- accommodation for temporary workers during launches; and,
- space tourism activity.

Employment associated with operation of the Proposed Project

4.9.2 Once built, the Proposed Project will allow for launches by multiple Launch Operators using a range of different launch vehicles. The Applicant is looking to achieve a maximum of 30 launch events per year.

4.9.3 The Applicant anticipates that there will be three high skilled jobs linked to the operation of the Proposed Project, as well as a series of supporting roles including security, maintenance and provision of accommodation for the Launch Operators temporary staff, who will be present prior to and immediately after each launch.

4.9.4 Each of the jobs identified has been allocated to an industrial sector and the anticipated location of the job established. Of the 98 jobs to be supported by full operation of the Proposed Project, 63 are expected to be based in Unst and 35 elsewhere within the Shetland Islands.

4.9.5 To estimate the GVA associated operation of the Proposed Project, anticipated job numbers have been multiplied by the relevant sectoral GVA per job, based on Scottish Annual Business Statistics and a study on the UK space sector, "Size and Health of the UK Space Industry 2018" (London Economics, 2019).

4.9.6 Supply chain impacts have been estimated by applying the relevant Scottish Type 1 GVA and employment multipliers from the Scottish Input-Output Tables (Scottish Government, 2019c) to the GVA and employment estimated above.

4.9.7 The impact from the spending of salaries and wages created by the operation of the Proposed Project has been estimated using data on the gross/net salary per job from the Scottish Annual Business Statistics the London Economics report. It has been assumed that residents in Unst spend 30 % of their salaries in Unst, 50 % in the Shetland Islands (including Unst) and 70 % in Scotland (including the Shetland Islands). Likewise, residents of the Shetland Islands were estimated to spend 5 % of their salaries in Unst, 50 % in the Shetland Islands and 70 % in Scotland[1]. Impacts from workers' expenditure was then estimated based on the ratios and multipliers of the household spending sector.

4.9.8 Summing these elements together, it is estimated employment associated with operation of the Proposed Project will generate £3.3 million GVA and support 68 jobs in Unst. For the Shetland Islands this increases to £5.3 million GVA and 119 jobs, and for Scotland, £6.2 million GVA and 137 jobs as shown in Table 4.9 below.

[1] where the spending taking place in the Shetland Islands and Scotland were estimated based on BiGGAR Economics' analysis of households spending patterns, as reported in (Office for National Statistics, 2019).
To account for the fact that ratios from the Scottish Annual Business Statistics do not account for taxation, it was then necessary to discount workers' expenditure by 8 %, the share of UK household spending that is devoted to Value Added Taxation according to a 2013 study from the European Commission (European Commission, 2013).

Table 4.9 Economic Impact – Employment associated with the Proposed Project

	Unst	Shetland Islands	Scotland
Employment	68	119	137
GVA (£m)	3.3	5.3	6.2

4.9.9 The effect associated with employment is therefore assessed as:

- major beneficial (**significant effect**) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

Accommodation for temporary workers during launches

4.9.10 Launch Operators will need to accommodate their own staff locally during preparation and decommissioning works prior to each launch. It is envisaged that some staff may also be permanently located in Unst, if Launch Operators find that they are using the Proposed Project on a frequent basis.

4.9.11 Launch Operators will pay for the maintenance (accommodation and food) of their staff while in Unst. This spending in turn will benefit local accommodation providers supporting their turnover and employment.

4.9.12 The Applicant anticipates that up to 50 Launch Operator workers will be stationed on Unst for around four weeks during the lead-up to any given launch event. By multiplying staff days required by the number of launches it is estimated that Launch Operator workers will stay on Unst for up to 42,000 days per year when the target of 30 launches per year is achieved.

4.9.13 Given the existing accommodation capacity in Unst and the available data on average occupancy rates for the Shetland Islands from the 2019 Scottish Accommodation Occupancy Survey (Moffat Centre et al., 2020), workers are unlikely to displace any other users of accommodation facilities in Unst. As a result, all of this impact is considered as additional.

4.9.14 Maintenance expenditure associated with these stays has been assumed to amount to an average of £50 per worker per day and, on this basis, spending on accommodation will amount to around £2.1 million, discounted by 8 % to account for spending on VAT.

4.9.15 By applying the turnover per GVA ratio from the Accommodation and Food Services activities from Scottish Annual Business Statistics, direct GVA and employment supported by this spending has been calculated. Supply chain impacts and income effects have been estimated by applying relevant Type 1 and Type 2 Scottish multipliers, as done in previous sections.

4.9.16 It is estimated that spending on food and accommodation from the temporary launch workers will generate £1.2 million GVA and support 55 jobs on Unst. For the Shetland Islands this increases to £1.4 million GVA and 59 jobs, and for Scotland £1.6 million GVA and 64 jobs as shown in Table 4.10 below.

Table 4.10 Economic Impact - Accommodation Spending

	Unst	Shetland Islands	Scotland
Employment	55	59	64
GVA (£m)	1.2	1.4	1.6

4.9.17 The effects associated with spending on accommodation is therefore assessed as:

- major beneficial (**significant effect**) for Unst; and,
- negligible for The Shetland Islands and Scotland.

Tourism Activity

4.9.18 Launches are anticipated to attract visitors to Unst and the Shetland Islands. Visitor spending will have economic benefits, supporting local businesses and increasing employment in the tourism sector.

4.9.19 The level of impact from tourism is based on the total number of visitors that are able to view any given launch. This will be constrained by the number of overnight stays available on Unst and by the capacity of the ferry links to carry visitors for day trips.

4.9.20 As set out previously, it is estimated that Unst has capacity for up to 230 overnight stays. However, 50 of these will be taken up by Launch Operator workers as described in the previous section. In addition, 20 of the visitors are anticipated to be senior staff from the Launch Operators. Consequently, it has been assumed that there will be capacity to accommodate 160 visitors per launch.

4.9.21 Ferry capacity for day trips has been estimated using data from Shetland Islands Council, which states that the monthly peak number of passengers on the ferry to Unst, Yell and Fetlar in 2019 was 20,381. (Shetland Islands Council, 2020). This equates to a daily maximum of around 657 people per day. As day visitors must also travel home following the event, the maximum number of day visitors has been estimated as 329. In total, it is estimated that a maximum of 489 visitors will be able to view any given launch.

4.9.22 To determine the number of visitors over a year, it has been assumed that the number of visitors will decline by 5 % for subsequent launches, to account for possible saturation interest. During the first year, when 10 launches are anticipated, visitor numbers are therefore estimated at 3,922. For future years when the target of 30 launches per year is achieved, this is estimated to rise to 7,677 visitors.

4.9.23 Not all tourism activity can be considered as additional. Given the constraints in accommodation and ferry capacity, some visitors may displace other tourists that would have otherwise visited Unst for other reasons. As a result, it has been assumed that around 90 % of tourism activity will be additional with respect to Unst, 80 % with respect to the Shetland Islands and 50 % with respect to Scotland.

4.9.24 It has been assumed that overnight visitors will spend on average £448 during their stay in the Shetland Islands (Shetland Islands Council, 2018). In terms of the Scottish economy, predicted spend is higher at £726 per visit and takes into account of travelling costs to reach the Shetland Islands. It has been assumed that day visitors to Unst will spend on average £36[2] on the island. These visitors are considered as overnight visitors from the perspective of their spending in the Shetland Islands and in Scotland. Tourism spending has been discounted by 8 % to account for VAT, which is not included in the ratios from the UK Input-Output tables and multipliers.

4.9.25 Direct GVA and employment have been estimated by applying the turnover per GVA and turnover per job ratios for the Tourism sector, constructed using a series of industrial sector codes linked to accommodation, food and beverage and leisure activities. Indirect and induced impacts were then estimated making use of Scottish GVA and employment Type 1 and Type 2 multipliers.

4.9.26 It is estimated that tourism due to the Proposed Project will generate £0.4 million GVA and support 17 jobs on Unst. For the Shetland Islands this increases to £0.8 million GVA and 30 jobs, and for Scotland £1.5 million GVA and 54 jobs as shown in Table 4.11 below.

[2] based on data from the Great Britain Day Visitor Survey for day visits to the Shetland Islands (Kantar, 2019)

Table 4.11 Tourism Impact

	Unst	Shetland Islands	Scotland
Employment	17	30	54
GVA (£m)	0.4	0.8	1.5

4.9.27 The effect from tourism activity related to the Proposed Project is assessed as being**:**

- major beneficial (**significant effect**) for Unst; and,
- negligible for The Shetland Islands and Scotland.

Summary of Operational Effects

4.9.28 Summing the beneficial effects resulting from employment associated with the operation of the Proposed Project, accommodation for temporary workers during launches and space tourism activity, as detailed in Table 4.12 below, it is considered that the Proposed Project will generate:

- £4.9 million GVA and 139 jobs in Unst (representing a substantial increase in employment);
- £7.5 million GVA and 209 jobs across the Shetland Islands; and,
- £9.3 million GVA and 255 jobs across Scotland.

Table 4.12 Total Economic Impact from Operation of Proposed Project

	Unst	Shetland Islands	Scotland
Employment	139	209	255
GVA (£m)	4.9	7.5	9.3

The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (**significant effect**) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

4.9.29 In addition, the Proposed Project is also expected to result in a series of wider, less quantifiable, benefits for the economies of Unst, the Shetland Islands and Scotland including:

- Making Scotland more competitive in the small satellite space sector, by providing a location from which launch activity could be carried out. This would complement the activities already carried out in the sector in Scotland and would mean that Scotland could offer the whole supply-chain for the small satellite sector.
- Diversifying the economic base of Unst and the Shetland Islands towards the space sector and away from the oil and gas industry, on which it currently relies heavily and is noted to be in decline. This diversification of the economic base may lead to an increase of the local economy's resilience.
- Offering a wider range of employment opportunities and new career paths available to young people in Unst and in the Shetland Islands.
- Acting as a catalyst for investment. Once the Proposed Project is fully operational, it may become convenient for some launch companies to have permanent staff on the Shetland Islands, instead of dispatching temporary workers for each launch. Investment may also come from businesses supporting the operations of the space

centre, as a reliable stream of work may encourage them to invest or lead to the emergence of new businesses seeking to benefit from space-related contracts.

- Encouraging investment in the tourism sector, as launch activities extend the tourism season and provide additional visitors to Unst and to the Shetland Islands with another reason to spend time there.

4.10 Mitigation and Further Studies

4.10.1 No mitigation is applicable to this chapter as the effects were all assessed as beneficial.

4.10.2 The Applicant is committed to a further study of the socio-economic effects of the Proposed Project as part of its preparations for operation. The Applicant has partnered with the Open University to research development of socio-economic opportunities arising from the Proposed Project beyond the usual indicators.

4.10.3 The Open University study will develop a stakeholder analysis framework to assess the socio-economic benefits of the Proposed Project as part of the UK's Launch UK spaceflight programme. It is recognised that space ports can involve highly sensitive, rural areas, and consultations for stakeholder input analysis regarding socio-economic benefit assessments must be carefully planned (and tailored to the specific locale) in collaboration with local partners. Working with the Applicant, the Open University team will determine the stakeholders involved in the space port and define the most appropriate consultation and analytical process, thus enabling the Open University's socio-economic benefits evaluation framework to be applied. The focus of the framework is on determining the less tangible socio-economic benefits that arise from such activities, beyond the traditional financial analyses performed to date.

4.10.4 The study is currently in progress and will be reported as appropriate on completion.

4.11 Residual Effects

4.11.1 As no mitigation is required, the residual effects on socio-economic characteristics are assessed as being effectively the same as the potential effects set out in Section 14.6 above, as summarised below.

4.11.2 The residual effects from the operational phase of the Proposed Project are assessed as being:

- major beneficial (**significant effect**) for Unst,
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

4.12 Cumulative Assessment

4.12.1 Cumulative effects can be either inter-project or intra-project effects.

4.12.2 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, there are no other existing or proposed developments with the potential to influence cumulative effects in the local EZI (Unst). The relative effect of the Proposed Project on the regional and national scale EZI has been assessed within this chapter already.

4.12.3 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. Whilst human health effects from the air quality and noise impacts are considered within this chapter, none of the effects directly impact between the disciplines and therefore there are no potential intra-project cumulative effects.

4.12.4 It is noted, however, that if the Proposed Project were to stimulate investment (for example, to provide additional visitor accommodation for those working on or viewing launches) or new entrepreneurial activity to take advantage of the supply chain opportunities that are expected to arise, this would further increase the economic impacts in the Unst and Shetland Islands economies, having a positive additive effect.

4.13 Summary

4.13.1 This chapter provides the human health and population assessment of the Proposed Project. The analysis has considered impacts associated with operation of the Proposed Project and how this fits into the local and national economic context.

4.13.2 The population of Unst has declined significantly over the last century, reaching 632 people in the latest Census (2011), and is expected to decrease further. The population decline has been caused in part by the closures of Baltasound Airport in 1996 and RAF Saxa Vord in 2006. These closures have also depressed job opportunities in Unst, and incomes in Unst and the North Isles tend to be lower than in other parts of the Shetland Islands. When compounded with higher living costs, this results in the area around the Proposed Project being one of the least affluent areas in the Shetland Islands.

4.13.3 The Proposed Project represents a transformational and much needed economic development opportunity for Unst and for the Shetland Isles and will generate significant beneficial local effects through:

- employment associated with operation of the Proposed Project;
- demand for goods and services to support the operation of the Proposed Project;
- hosting temporary workers from the launch companies who will then utilise local shops, hospitality and other amenities; and,
- attracting tourists who will visit to watch launches and/or explore the Proposed Project (including outside the current summer tourism season).

4.13.4 The predicted economic effects are considered to be major beneficial (**significant**) locally.

4.13.5 Full operation of the Proposed Project will see a maximum of 30 launch events per year. During operation, beneficial economic impacts are expected to arise from three main sources:

- employment associated with operation of the Proposed Project;
- accommodation for temporary workers during launches; and,
- space tourism activity.

4.13.6 It is estimated that employment associated with this level of activity will generate:

- £3.3 million GVA and support 68 jobs in Unst;
- £5.3 million GVA and support 119 jobs in The Shetland Islands; and,
- £6.2 million GVA and support 137 jobs across Scotland.

4.13.7 Spending on accommodation for temporary workers during launches is estimated to generate:

- £1.2 million GVA and support 55 jobs in Unst;
- £1.4 million GVA and support 59 jobs in The Shetland Islands; and,
- £1.6 million GVA and support 64 jobs across Scotland.

4.13.8 Spending by visitors coming to Unst for space tourism is estimated to generate:

- £0.4 million GVA and support 17 jobs in Unst;
- £0.8 million GVA and support 30 jobs in The Shetland Islands; and,
- £1.5 million GVA and support 54 jobs across Scotland.

4.13.9 Summing all these impacts together, it is estimated that the total impact from operation of the Proposed Project will be:

- £4.9 million GVA and 139 jobs in Unst;
- £7.5 million GVA and 209 jobs in The Shetland Islands; and,
- £9.3 million GVA and 255 jobs in Scotland.

4.13.10 The total effect from operation of the Proposed Project is therefore assessed as being:

- major beneficial (**significant**) for Unst;
- minor beneficial for The Shetland Islands; and,
- negligible for Scotland.

4.13.11 In addition, the Proposed Project is also expected to result in a series of wider, less quantifiable, benefits for the economies of Unst, the Shetland Islands and Scotland including:

- Making Scotland more competitive in the small satellite space sector, by providing a location from which launch activity could be carried out.
- Diversifying the economic base of Unst and the Shetland Islands towards the space sector.
- Offering a wider range of employment opportunities and new career paths available to young people in Unst and in the Shetland Islands.
- Acting as a catalyst for further investment; and,
- Encouraging investment in the tourism sector, as launch activities extend the tourism season and provide additional visitors to Unst and to the Shetland Islands.

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Appendix 2.6 SaxaVord Spaceport AEE Material Assets and Cultural Heritage Chapter

CHAPTER 14 MATERIAL ASSETS AND CULTURAL HERITAGE

14. Material Assets and Cultural Heritage

14 Material Assets and Cultural Heritage

14.1 Introduction

14.1.1 This chapter considers the issues associated with the likely significant cultural heritage effects of the Proposed Project.

14.1.2 This chapter has been produced by AOC Archaeology Group, a Registered Organisation of the Chartered Institute for Archaeologists (CIfA). The assessment has been carried out by Victoria Oleksy and Lisa Bird of AOC Archaeology Group. Victoria Oleksy is an Assistant Director and Consultancy Sector Head with over 15 years of experience working on cultural heritage assessments. Victoria specialises in EIAs, Archaeological Impact Assessment and Conservation Management Plans and has appeared as an expert witness for planning appeals and called-in planning applications. Lisa Bird is a Project Officer with five years of experience working on a range of EIAs, desk-based assessments and large walkover survey projects.

14.1.3 This assessment has been carried out in accordance with the standards of professional conduct outlined in the CIfA *Code of Conduct* (CIfA, 2021) and *Regulations for Professional Conduct* (CIfA, 2019), as well as the CIfA *Standard and guidance for commissioning work on, or providing consultancy advice on, archaeology and the historic environment* (CIfA, 2014a); *Standard and guidance for historic environment desk- based assessment* (CIfA, 2017); field evaluations (CIfA, 2020) and other relevant guidance.

14.1.4 This assessment makes the distinction between designated heritage assets, referred to as 'designated assets', which have statutory designations (including Scheduled Monuments and Listed Buildings), and 'heritage features', which relate to non-designated assets which have no statutory designation but are protected under national and local planning policy. Individual elements within Skaw radar station (centred Site 3; hereafter RAF Skaw) and Inner Skaw (Site 2) which make up part of these larger designated assets and are statutorily protected are also referred to as 'heritage features.' Hitherto unknown buried archaeological remains are referred to as 'remains'.

14.1.5 This assessment considers the potential for effects on cultural heritage and archaeology associated with the operation of the Proposed Project. The specific objectives of the chapter are to:

- describe the cultural heritage baseline;
- describe the assessment methodology and significance criteria used in completing the effect assessment;
- assess the potential for direct effects on designated assets and non-designated heritage features and remains resulting from operation of the Proposed Project;
- assess the setting effects upon designated assets within the Site and the 1 km cultural heritage study area during the operational phase;
- identify measures that would mitigate or offset any predicted significant adverse effects; and,
- assess the significance of residual effects following the implementation of mitigation.

14.1.6 This chapter is supported by the Drawings and Appendices presented in Table 14.1. All site numbers referred to in the text and Drawings relate to designated assets and heritage features listed in the Site Gazetteer (Appendix 14.1)

Table 14.1 List of Drawings and Appendices in Volume 3 and 4 Respectively

Document Title	Document Description
Drawing 14.1	Designated Assets in the Proposed Project Site and the study area
Drawing 14.2a-c	Heritage features in the Proposed Project Site
Drawing 14.3	Heritage features in the study area of the Proposed Project
Drawing 14.4	Proposed Project Site - Extract from Ordnance Survey map, 1882
Appendix 14.1	Cultural Heritage Site Gazetteer
Appendix 14.2	Cultural Heritage Plates
Appendix 14.3	Consultation Meeting Notes
Appendix 14.4	Cultural Heritage Viewpoints
	Cultural Heritage Viewpoint Location Plan
	Cultural Heritage Viewpoint 1: Inner Skaw Scheduled Monument (Site 2)
	Cultural Heritage Viewpoint 2: RAF Skaw Interpretation Board
	Cultural Heritage Viewpoint 3: Advance Chain Home (ACH) Transmitter (Site 96)
	Cultural Heritage Viewpoint 4: Chain Home (CH) Transmitter (Site 85)
	Cultural Heritage Viewpoint 5: Gun and Crew Shelter (Site 74)
	Cultural Heritage Viewpoint 6: Track (Site 85hh) looking towards CH Transmitter (Site 85)
	Cultural Heritage Viewpoint 7: CH/S Power House (Site 93)
	Cultural Heritage Viewpoint 8: CH Receiver Block (Site 111)
Appendix 14.5	Review of Existing Structures
Appendix 14.6	Detailed Archaeological & Historical Background
Appendix 14.7	Results of Walkover Survey
Appendix 14.8	Data Structure Report: RAF Skaw, Watching Brief on Ground Investigation Works
Appendix 14.9	Draft Interpretation Strategy
Appendix 14.10	Conservation Management Plan

14.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

14.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;

- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

14.2.2 As the applicant wishes to operate a vertical spaceport (at the SaxaVord Spaceport) and provide range control services (at the Launch and Range Control Centre, LRCC) they are required to apply for a both a spaceport licence and a range control licence.

Space Industry Regulations 2021

14.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Statutory Framework for Heritage

14.2.4 The statutory framework for heritage in Scotland is outlined in the Town and Country Planning (Scotland) Act 1997 (HMSO, 1997a), as amended in the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997 (HMSO, 1997b) and the Ancient Monuments and Archaeological Areas Act 1979 (HMSO, 1979) both of which are modified by the Historic Environment (Amendment) (Scotland) Act 2011 (HMSO, 2011).

14.2.5 The Proposed Project is located within the southern portion of the Scheduled Monument of Skaw, radar station (centred Site 3; hereafter RAF Skaw). As such Scheduled Monument Consent (SMC) will be required for works within the RAF Skaw Scheduled Monument in line with the Ancient Monuments and Archaeological Areas Act 1979.

14.2.6 Historic Environment Scotland's (HES) Scheduled Monument Consents Policy (SMCP) (HES, 2019a) sets out policies applied to consent decisions with regard to proposals for work on Scheduled Monuments. The following policies are relevant to this assessment:

- *'SMCP1: When undertaking works to scheduled monuments, their significance should be maintained.*
- *SMCP3: Extensive intervention to a scheduled monument will only be allowed where:*
    - it has minimal effect on the cultural significance of the monument; or
    - it is clearly necessary to secure the long-term preservation of the monument; or
    - it will clearly generate public benefits of national importance which outweigh the impact on the nationally important cultural significance of the monument. Such public benefits could come from, for example, interventions which improve public access to a scheduled monument (where appropriate) or assist public understanding once the works are completed or provide economic benefits of national importance once completed.
- *SMCP4: Proposals for change should be carefully considered, based on good authority, sensitively designed, and properly planned and executed. The level of information provided should be in proportion to the sensitivity of the monument or feature and the level of change proposed.'*

Planning Policy

14.2.7 The implications of the Acts noted above, with regard to government planning policy, are described within Scottish Planning Policy (SPP) (Scottish Government, 2014), Historic Environment Policy for Scotland (HEPS) (HES, 2019b) and Planning Advice Notes (PAN) for Scotland. SPP, HEPS and PAN 2/2011 'Archaeology and Planning' (Scottish Government, 2011) deal specifically with planning policy in relation to heritage. The planning guidance expresses a general presumption in favour of preserving designated assets and non-designated features in situ. Their 'preservation by record' (i.e., through excavation and recording, followed by analysis and publication, by qualified archaeologists) is a less desirable alternative. SPP expresses the following policy principles:

'The planning system should:

- *promote the care and protection of the designated and non-designated historic environment (including individual assets, related settings and the wider cultural landscape) and its contribution to sense of place, cultural identity, social well-being, economic growth, civic participation and lifelong learning; and*
- *enable positive change in the historic environment which is informed by a clear understanding of the importance of the heritage assets affected and ensure their future use. Change should be sensitively managed to avoid or minimise adverse impacts on the fabric and setting of the asset, and ensure that its special characteristics are protected, conserved or enhanced' (Scottish Government 2014, Para 137).*

14.2.8 HEPS (HES, 2019b) sets out the Scottish Government's policy for decision making that affects the historic environment. It contains six policies for managing the historic environment, all of which favour protection, understanding and promotion of the historic environment as well as the preservation of the benefits of the historic environment for future generations. Historic environment policies 3 and 4 both state '*if detrimental impact on the historic environment is unavoidable, it should be minimised. Steps should be taken to demonstrate that alternatives have been explored, and mitigation measures should be in place*' (HES, 2019b). The following historic environmental policies are relevant to this assessment:

- *'HEP1: Decisions affecting any part of the historic environment should be informed by an inclusive understanding of its breadth and cultural significance.*
- *HEP2: Decisions affecting the historic environment should ensure that its understanding and enjoyment as well as its benefits are secured for present and future generations.*
- *HEP3: Plans, programmes, policies and strategies and the allocation of resources should be approached in a way that protects and promotes the historic environment.*

  If detrimental impact on the historic environment is unavoidable, it should be minimised. Steps should be taken to demonstrate that alternatives have been explored and mitigation measures should be put in place.
- *HEP4: Changes to specific assets and their context should be managed in a way that protects the historic environment. Opportunities for enhancement should be identified where appropriate.*

  If detrimental impact on the historic environment is unavoidable, it should be minimised. Steps should be taken to demonstrate that alternatives have been explored, and mitigation measures should be put in place.'

14.2.9 The sites are located in Unst, Shetland and the local authority is the Shetland Islands Council. Shetland Islands Council adopted the Local Development Plan (LDP) in September 2014 (SIC, 2014). The LDP sets out the vision and spatial strategy for the development of land in the Shetland Islands for the forthcoming 10 to 20 years.

14.2.10 The Historic Environment is recognised as having value and through the planning system Shetland Islands Council seeks to manage the Historic Environment in a sustainable way. The following policies are relevant to this assessment:

- *HE1 Historic Environment: The Council should presume in favour of the protection, conservation and enhancement of all elements of Shetland's historic environment, which includes buildings, monuments, landscapes and areas.*
- *HE2 Listed Buildings: Development affecting a listed building, or its setting, should preserve the building, its setting, and any features of special architectural or historic interest that it possesses.*
- *HE4 Archaeology: Scheduled monuments, designated wrecks and other identified nationally important archaeological resources should be preserved in situ, and within an appropriate setting. Developments that have an adverse effect on scheduled monuments and designated wrecks or the integrity of their settings should not be permitted unless there are exceptional circumstances.*

  All other significant archaeological resources should be preserved in situ wherever feasible. Where preservation in situ is not possible the planning authority should ensure that developers undertake appropriate archaeological excavation, recording, analysis, publication and archiving in advance of and/ or during development. (SIC, 2014: 31-34)

14.2.11 Shetland Islands Council published draft Supplementary Guidance on the Historic Environment (SGHE) in 2012 (SIC, 2012). The draft Supplementary Guidance sets out the policies which affect the historic environment and the setting of individual elements of the historic environment. The following draft policy is relevant to this assessment:

- *Policy SGHE 3 Archaeological assessment: Where archaeological remains are known or thought likely to exist the developer may be requested to supply a report of an archaeological evaluation prior to determination of a planning or listed building consent application.*

14.2.12 Shetland Islands Council planned for the emerging Local Development Plan 2 (LDP2) to be published in August 2019. However, at the time of writing, LDP2 has still not been published.

Guidance

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

14.2.13 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objective for spaceflight are to:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*
- *Protect people and wildlife from the impacts of noise from spaceflight activities;*
- *Protect the marine environment from the impact of spaceflight activities.*

Guidance for the Assessment of Environmental Effects

14.2.14 The Guidance for the Assessment of Environmental Effects (AEE) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

14.2.15 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including noise and vibration, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;
- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants for a spaceport licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including material assets and cultural heritage.

HES Setting Guidance

14.2.16 HES's setting guidance defines setting as *'the way the surroundings of a historic asset or place contribute to how it is understood, appreciated, and experienced'* (HES, 2016, updated 2020). The guidance further notes that *'planning authorities must take into account the setting of historic assets or places when drawing up development plans and guidance, when considering various types of environmental and design assessments/statements, and in determining planning applications'*. It advocates a three-stage approach to assessing potential impacts upon setting which is followed by the setting assessment included in this assessment. The three-stage approach includes:

- Stage 1: Identify the historic asset;
- Stage 2: define and analyse the setting; and,
- Stage 3: evaluate the potential impact of the proposed changes.

14.3 Consultation

14.3.1 Extensive statutory consultation in relation to material assets and cultural heritage was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 14.2.

Table 14.2 Consultation Relevant to AEE

Consultee	Summary	Response
Historic Environment Scotland (HES) Pre-Application Consultation Case ID: 300044616 (29th May 2020)	The Proposed Project is located within the Scheduled Monument known as Skaw, radar station (SM13097-centred Site 3- Drawing 14.1).	Direct and settings impacts on RAF Skaw and Inner Skaw were discussed at length within the EIA and as required are summarised for the operational phase in this AEE chapter. The settings assessment is cognisant of the relationship between the north and

Consultee	Summary	Response
		southern portions of RAF Skaw, as well as the character, setting and legibility of the surviving remains within the Scheduled Monument. Impacts upon the settings of other designated assets within 1 km have also been considered.
Historic Environment Scotland (HES) (16th June 2020) Meeting included Shetland Regional Archaeologist (Shetland Amenity Trust (SAT))	Cultural Heritage and Archaeology to be considered in the EIA. Cultural Heritage visualisations to be included and agreed with HES and SAT. An assessment of the direct impact of vibration on the upstanding RAF features within the Proposed Project needs to be undertaken.	Also included for the operational phase in the AEE at the request of the CAA. Proposed Cultural Heritage visualisation locations were submitted to HES on 10th July 2020 and were confirmed to HES on the 17th August 2020. AEE Chapter 8: Noise and Vibration
Val Turner, Regional Archaeologist Shetland Amenity Trust (SAT) (23rd July 2020- on-site)	Consultation on the proposed Cultural Heritage visualisations to be produced for the Proposed Project.	In addition to the proposed Cultural Heritage visualisations submitted on the 10th July 2020, three further visualisations were identified and agreed on-site and confirmed on 17th August 2020.

14.3.2 Upon review of the submitted Planning Application and EIA Report for the Proposed Project, HES issued a statutory consultation response on 29th March 2021 objecting to the planning application and requesting that further work be undertaken with the aim of reducing effects on the Historic Environment assets of the site at Lamba Ness, principally arising from direct effects on the derelict structures of the former Skaw Radar Station (Scheduled Monument 13097).

14.3.3 A review of the Proposed Project Site Layout was undertaken in response to HES' consultation comment on the planning application (Planning Application Reference 2021/005/PPF) that 'there is no indication that any alteration in design was considered to relocate this area to avoid the impact on these features despite the presence of open areas without known features in the near vicinity'.

14.3.4 Heritage assets impacted by the original design were reviewed, resulting in further changes to the site layout design:

- Car Park moved from the south to the west of the Administration Building.
- Hardstanding to the north of the assembly area moved east.
- Road and future west Assembly buildings moved as a block east.
- Hangar building moved to the south of the existing road.

14.3.5 These alterations have been included in the description of the Proposed Project included in Chapter 3 and are used as the basis of this assessment for AEE.

14.4 Assessment Methodology and Significance Criteria

Consultation

14.4.1 Consultation was undertaken directly with the relevant consultees namely HES and the Shetland Regional Archaeologist at Shetland Amenity Trust (SAT), as advisor to Shetland Islands Council. Online meetings were held with the Shetland Regional Archaeologist on the 26th May 2020 and with HES and the Shetland Regional Archaeologist on 16th June 2020 and 19th November 2020. The Shetland Regional Archaeologist also undertook a site visit with AOC on 23rd July 2020. A number of consultation responses were provided by HES as detailed in Table 14.2 above.

14.4.2 Upon review of the submitted Planning Application and EIA Report for the Proposed Project, HES issued a statutory consultation response on 29th March 2021 objecting to the planning application and requesting that further work be undertaken with the aim of reducing effects on the Historic Environment assets of the site at Lamba Ness, principally arising from direct effects on the derelict structures of the former Skaw Radar Station (Scheduled Monument 13097).

14.4.3 Heritage assets impacted by the original design were reviewed, resulting in further changes to the site layout design as described above.

Environmental Zone of Influence (EZI)

14.4.4 The Study Area for cultural heritage and archaeology comprising the Proposed Project boundary and an area of 1 km surrounding was identified for this assessment. This was considered to be sufficient to develop an historic environment baseline, identify assets which could be subject to impact and to identify archaeological potential. The Study Area is deemed sufficient given the height and nature of the Proposed Project and the density of known designated assets and heritage features within the study area. The study area was subject to agreement with HES and SAT during initial meetings as detailed above. The Study Area for cultural heritage and archaeology lies within the overall EZI for the AEE.

Desk Study

14.4.5 Data on known designated assets and heritage features within the sites and in the surrounding study area has been collated from the following sources:

- HES
  - National Record of Historic Environment (NRHE) data (downloaded in March 2020);
  - Designated asset data (downloaded in July 2020); and,
  - Published and unpublished archaeological reports.
- Shetland Amenity Trust (SAT) Sites and Monuments Record (SMR) obtained in May 2020
  - Designated heritage asset and heritage features as recorded by the Shetland Islands SMR; and,
  - Unpublished archaeological reports (referred to as Events).
- National Library for Scotland
  - Ordnance Survey maps and pre-Ordnance Survey historical maps.
- National Collection of Aerial Photography (NCAP), held by HES

- Vertical and oblique historic aerial photographs online and as reproduced in the Unexploded Ordnance assessment by Zetica (Zetica, 2020).

- Walkover Surveys and Site Visits
    - Walkover surveys of the Sites and site visits to designated assets within the study area were undertaken between 20th and 25th July 2020.
- Shetland Museum and Archives
    - Archival material including pre-Ordnance Survey mapping, and unpublished reports were viewed at the Shetland Museum and Archives, Lerwick on the 24th July 2020 by appointment.
- A History of RAF Saxa Vord blogpost
    - A series of blogs disseminating documentary research and oral histories relating to the Royal Airforce (RAF) bases on Unst were reviewed. Several relate to the construction, use and abandonment of the Scheduled Skaw, radar station, the former RAF Skaw.

Site Visit

14.4.6 A walkover survey of the Site was undertaken between the 20th and 25th July 2020. The survey was undertaken with the aim of identifying any previously unknown heritage features, and to confirm the presence and extent of previously recorded designated assets and heritage features. All known and accessible designated assets and heritage features were assessed in the field to establish their survival, extent, significance, and relationship to other designated assets and heritage features. Weather and any other conditions affecting the visibility during the surveys were also recorded. All heritage features encountered were recorded and photographed. The location of features noted in the field was recorded on an US GPS Navstar enabled iPad using ESRI's ArcGIS Collector software or an iPhone using iGIS. All features were recorded directly through ArcGIS Collector and iGIS in full British National Grid coordinates.

Assessment of Potential Effect Significance

14.4.7 This assessment distinguishes between the term 'impact' and 'effect'. An impact is defined as a physical change to a designated asset, heritage feature or its setting, whereas an effect refers to the significance of this impact. The first stage of the assessment involves establishing the value and importance of the designated assets and/or heritage feature and assessing the sensitivity of the asset or feature to change (impact). Using the proposed design for the Proposed Project, an assessment of the impact magnitude is made and a judgement regarding the level and significance of effect is arrived at.

Criteria for Assessing Sensitivity of Heritage Assets

14.4.8 The definition of cultural significance is readily accepted by heritage professionals both in the UK and internationally and was first fully outlined in the Burra Charter, which states in article one that 'cultural significance' or 'cultural heritage value' means aesthetic, historic, scientific, social or spiritual value for past, present or future generations (ICOMOS, 2005). This definition has since been adopted by heritage organisations around the world, including HES. HEPS notes that to have cultural significance an asset must have a particular '*aesthetic, historic, scientific or social value for past, present and future generations*' (HES, 2019b). Heritage assets also have value in the sense that they '*...create a sense of place, identity and physical and social wellbeing, and benefits the economy, civic participation, tourism and lifelong learning*' (Scottish Government, 2014).

14.4.9 All assets and/or features have significance; however, some are judged to be more important than others. The level of that importance is, from a cultural resource management perspective, determined by establishing the asset or feature's capacity to contribute to our understanding or appreciation of the past (HES, 2019c). In the case of designated assets their importance has already been established through the designation (i.e., Scheduling, Listing and Inventory) processes applied by HES.

14.4.10 The rating of importance of assets and features is first and foremost made in reference to their designation. For non-designated assets importance will be assigned based on professional judgement and guided by the criteria presented in Table 14.3; which itself relates to the criteria for designations as set out in Designation Policy and Selection Guidance (HES, 2019c) and Scotland's Listed Buildings (HES, 2019d).

Table 14.3: Criteria for Establishing Relative Importance of Designated Assets and Heritage Features

Importance	Receptors
Very High	World Heritage Sites (as protected by SPP, 2014); Other designated or non-designated assets or heritage features with demonstrable Outstanding Universal Value.
High	Scheduled Monuments (as protected by the Ancient Monuments and Archaeological Areas Act 1979 (the '1979 Act'); Category A Listed Buildings (as protected by the Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997) (the '1997 Act'); Inventory Gardens and Designed Landscapes (as protected by the 1979 Act, as amended by the Historic Environment (Amendment) (Scotland) Act 2011); Inventory Battlefields (as protected by the 1979 Act, as amended by the 2011 Act); Outstanding examples of some period, style or type; Non-Designated features considered to meet the criteria for the designations as set out above (as protected by SPP, 2014).
Medium	Category B and C Listed Buildings (as protected by the 1997 Act); Conservation Areas (as protected by the 1997 Act); Major or representative examples of some period, style or type; or Non-designated features considered to meet the criteria for the designations as set out above (as protected by SPP, 2014);
Low	Locally Listed assets; Examples of any period, style or type which contribute to our understanding of the historic environment at the local level.
Negligible	Relatively numerous types of features; Findspots of artefacts that have no definite archaeological remains known in their context; The above non-designated features are protected by Paragraph 137 of SPP, 2014.

14.4.11 Determining cultural heritage significance can be made with reference to the intrinsic, contextual and associative characteristics of an asset or feature as set out in HEPS (HES, 2019b) and its accompanying Designation Policy and Selection Guidance (HES, 2019c). HEPS Designation Policy and Selection Guidance (HES, 2019c) indicates that the relationship of an asset or feature to its setting or the landscape makes up part of its contextual characteristics. The Xi'an Declaration (ICOMOS, 2005) set out the first internationally accepted definition of setting with regard to heritage assets and features, indicating that setting is important where it forms part of or contributes to the significance of a heritage asset or feature. While SPP does not differentiate between the importance of the asset itself and the importance of the asset's setting, HES's

Managing Change Guidance on setting (HES, 2016, updated 2020b), in defining what factors need to be considered in assessing the impact of a change on the setting of a historic asset or place, states that the magnitude of the proposed change should be considered *'relative to the sensitivity of the setting of an asset'* ; thereby making clear that assets vary in their sensitivity to changes in setting and thus have a relative sensitivity.

14.4.12 The EIA Handbook suggests that cultural significance aligns with sensitivity but also states that *'the relationship between value and sensitivity should be clearly articulated in the assessment'* (SNH et al., 2018). It is therefore recognised that the importance of an asset or feature is not the same as its sensitivity to changes to its setting. Elements of setting may make a positive, neutral or negative contribution to the significance of an asset. Thus, in determining the nature and level of effects upon assets and their settings by the development, the contribution that setting makes to an asset or feature's significance and thus its sensitivity to changes to setting needs to be considered.

14.4.13 This approach recognises the importance of preserving the integrity of the setting of an asset or feature in the context of the contribution that setting makes to the experience, understanding and appreciation of a given asset or feature. It recognises that setting is a key characteristic in understanding and appreciating of some, but by no means all, assets and features. Indeed, assets or features of High or Very High importance do not necessarily have high sensitivity to changes to their settings (e.g., do not necessarily have a high relative sensitivity). An asset or feature's relative sensitivity to alterations to its setting refers to its capacity to retain its ability to contribute to our understanding and appreciation of the past in the face of changes to its setting. The ability of an asset or feature's setting to contribute to an understanding, appreciation and experience of it and its significance also has a bearing on the sensitivity of that asset to changes to its setting. While heritage assets or features of High or Very High importance are likely to be sensitive to direct effects, not all will have a similar sensitivity to effects on their setting; this would be true where setting does not appreciably contribute to their significance. The HES guidance on setting makes clear that the level of effect may relate to *'the ability of the setting* [of an asset or feature] *to absorb new development without eroding its key characteristics'* (HES, 2016, updated 2020b). Assets or features with Very High or High relative sensitivity to settings effects may be vulnerable to any changes that affect their settings, and even slight changes may erode their key characteristics or the ability of their settings to contribute to the understanding, appreciation and experience of them. Assets or features whose relative sensitivity to changes to their setting is lower, may be able to accommodate greater changes to their settings without having key characteristics eroded.

14.4.14 The criteria used for establishing an asset or feature's relative sensitivity to changes to its setting is detailed in Table 14.4. This table has been developed based on AOC's professional judgement and experience in assessing setting effects. It has been developed with reference to the policy and guidance noted above including SPP (Scottish Government, 2014), HEPS (HES, 2019b) and its Designation Policy and Selection Guidance (HES, 2019c), the Xi'an Declaration (ICOMOS, 2005), the EIA Handbook (SNH et al., 2018) and HES's guidance on the setting of heritage assets and features (HES, 2016, updated 2020b).

Table 14.4 – Criteria for Establishing Relative Sensitivity of a Heritage Asset to Changes to its Setting

Relative Sensitivity	Criteria
Very High	An asset or feature, the setting of which, is critical to the ability to understand, appreciate and experience it should be thought of as having Very High Sensitivity to changes to its setting. This is particularly relevant for assets or features whose settings, or elements thereof, make an essential direct contribution to their cultural significance (e.g., form part of their Contextual Characteristics (HES, 2019c).
High	An asset or feature, the setting, of which, makes a major contribution to an understanding, appreciation and experience of it should be thought of as having High Sensitivity to changes to its setting. This is particularly relevant

Relative Sensitivity	Criteria
	for assets or features whose settings, or elements thereof, contribute directly to their cultural significance (e.g., form part of their Contextual Characteristics (HES, 2019c)).
Medium	An asset or feature, the setting of which, makes a moderate contribution to an understanding, appreciation and experience of it should be thought of as having Medium Sensitivity to changes to its setting. This could be an asset or feature for which setting makes a contribution to significance but whereby its value is derived mainly from its other characteristics (HES, 2019c).
Low	An asset or feature, the setting of which, makes some contribution to an understanding, appreciation and experience of it should generally be thought of as having Low Sensitivity to changes to its setting. This may be an asset or feature whose value is predominantly derived from its other characteristics
Marginal	An asset or feature whose setting makes minimal contribution to an understanding, appreciation and experience of it should generally be thought of as having Marginal Sensitivity to changes to its setting.

14.4.15 The determination of an asset or feature's relative sensitivity to changes to its setting is first and foremost reliant upon the determination of its setting and the key characteristics of setting which contribute to its cultural significance and an understanding and appreciation of that cultural significance. This aligns with Stage 2 of the HES guidance on setting (HES, 2016, updated 2020b). The criteria set out in Table 14.4 are intended as a guide. Assessment of individual assets and features is informed by knowledge of the asset or feature itself; of the asset or feature type if applicable and by site visits to establish the current setting of the assets and features. This will allow for the use of professional judgement and each asset and/or feature is assessed on an individual basis.

Criteria for Assessing Magnitude of Impact

14.4.16 Potential impacts, that is the physical change to known designated assets, heritage features, and unknown buried archaeological remains, or changes to their settings, in the case of the Proposed Project relate to the possibility of disturbance to upstanding RAF features due to vibrations during the operational phase or the placement of new features within their setting during the operational phase.

14.4.17 The magnitude of the impacts upon designated assets or heritage features caused by operation of the Proposed Project is rated using the classifications and criteria outlined in Table 14.5.

Table 14.5- Criteria for Classifying Magnitude of impact

Magnitude of impact	Criteria
High	Substantial loss of information content resulting from total or large-scale removal of deposits from an asset or feature; Major alteration of an asset's baseline setting, which materially compromises the ability to understand, appreciate and experience the contribution that setting makes to the significance of the asset or feature and erodes the key characteristics (HES 2020) of the setting.
Medium	Loss of information content resulting from material alteration of the baseline conditions by removal of part of an asset or feature; Alteration of an asset or feature's baseline setting that effects the ability to understand, appreciate and experience the contribution that setting makes to the significance of the asset to a degree but whereby the

Magnitude of impact	Criteria
	cultural significance of the monument in its current setting remains legible. The key characteristics of the setting (HES 2020) are not eroded.
Low	Detectable impacts leading to minor loss of information content. Alterations to the asset or feature's baseline setting, which do not affect the ability to understand, appreciate and experience the contribution that setting makes to the asset or feature's overall significance.
Negligible	Loss of a small percentage of the area of an asset or feature's peripheral deposits; A reversible alteration to the fabric of the asset or feature; A marginal alteration to the asset or feature's baseline setting.
None	No effect predicted

Criteria for Assessing Significance

14.4.18 The predicted level of effect on each designated asset or heritage feature is then determined by considering the asset or feature's importance and/or relative sensitivity in conjunction with the predicted magnitude of the impact. The method of deriving the level of effect is provided in Table 14.6.

Table 14.6 - Level of Effect based on Inter-Relationship between the Sensitivity of a Heritage Asset and/or its setting and the Magnitude of Impact

Magnitude of Impact	Important and/or Sensitivity				
	Negligible	Low	Medium	High	Very High
High	Minor	Moderate	Moderate	Major	Major
Medium	Negligible/Neutral	Minor	Moderate	Moderate	Major
Low	Negligible/Neutral	Negligible/Neutral	Minor	Minor	Moderate
Negligible	Negligible/Neutral	Negligible/Neutral	Negligible/Neutral	Minor	Minor

14.4.19 The level of effect is judged to be the interaction of the asset or feature's importance and/or relative sensitivity (Tables 14.3 and/or 14.4) and the magnitude of the impact (Table 14.5). In order to provide a level of consistency, the assessment of importance and relative sensitivity, the prediction of magnitude of impact and the assessment of level of effect is guided by pre-defined criteria. However, a qualitative descriptive narrative is also provided for each asset to summarise and explain each of the professional value judgements that have been made in establishing sensitivity and magnitude of impact for each individual asset.

14.4.20 Using professional judgment and with reference to the Guidelines for Environmental Impact Assessment (as updated) (IEMA, 2017), and the EIA Handbook (SNH et al., 2018) the assessment considers moderate and greater effects to be significant (shaded grey in Table 14.6), while minor and lesser effects are considered not significant.

Integrity of Setting

14.4.21 SPP notes that where there is potential for a proposed project to have an adverse effect on a Scheduled Monument or on the integrity of its setting permission should only be granted where there are '*exceptional circumstances*'. Adverse effects on integrity of setting are judged here to relate to whether a change would adversely affect those attributes or elements of setting which contribute to an asset or feature's significance to the extent that the ability to understand and appreciate the asset is diminished.

14.4.22 In terms of effects upon the setting of designated assets or heritage features, it is considered that only those effects identified as 'significant' in the assessment will have the potential to adversely affect integrity of setting. Where no significant effect is found it is considered that the integrity of an asset or feature's setting will remain intact. This is because for many assets and features, setting may make a limited contribution to their significance and as such changes would not affect integrity of their settings. Additionally, as set out in Table 14.5, lower ratings of magnitude of change relate to changes that would not obscure or erode key characteristics of setting.

14.4.23 Where significant effects are found, a detailed assessment of adverse effects upon integrity of setting is made. Whilst non-significant effects are unlikely to affect integrity of setting, the reverse is not always true. That is, the assessment of an effect as being 'significant' does not necessarily mean that the adverse effect to the asset's or feature's setting will harm its integrity. The assessment of adverse effect upon the integrity of an asset or feature's setting, where required, will be a qualitative one, and will largely depend upon whether the effect predicted would result in a major impediment to the ability to understand or appreciate the designated asset or heritage feature such that its cultural significance is reduced.

Requirements for Mitigation

14.4.24 National and local planning policies and planning guidance outlined in Section 14.2, require a mitigation response that is designed to take cognisance of the possible impacts upon heritage assets and/or features by a proposed project and avoid, minimise or offset any such impacts as appropriate. The planning policies and guidance express a general presumption in favour of preserving heritage assets, features and remains in situ wherever possible. Their 'preservation by record' (i.e., through excavation and recording, followed by analysis and publication, by qualified archaeologists) is a less desirable alternative (Scottish Government, 2014), (SIC, 2014).

Assessment of Residual Effect Significance

14.4.25 The residual impact is what remains following the application of mitigation and management measures and is thus the final level of impact associated with the Proposed Project. The level of direct residual effect is defined using criteria outlined in Tables 14.3, 14.5 and 14.6. No direct mitigation, beyond those embedded in the in the Proposed Project's design, is possible for setting effects of the Proposed Project and therefore residual effects on the setting of heritage assets and/or feature will be the same as predicted without mitigation.

Limitations to Assessment

14.4.26 This assessment is based upon data obtained from publicly accessible archives as described in the Data Sources. Sites and Monuments Record (SMR) data was received in May 2020 and NRHE data on known heritage assets was downloaded from HES in March 2020 and checked in July 2020. This assessment does not include any records added after this date.

14.4.27 Access to historic vertical and oblique aerial photography is currently limited due to Covid-19 restrictions. AOC Archaeology Group have a subscription to NCAP and as such any available aerial photography which is available online has been viewed. Further copies of relevant aerial photographs obtained by Zetica for the unexploded ordnance assessment have been examined (Zetica 2020).

14.4.28 Due to Covid-19 Unst Heritage Centre was unfortunately be closed throughout 2020. Access to archival material held by Unst Heritage Centre regarding the former RAF Skaw was provided digitally by Lynn Thomson, Unst Heritage Centre.

14.4.29 Nevertheless, the assessment is considered to be robust and is based upon accepted principles of assessment.

14.5 Baseline Conditions

14.5.1 This section presents a summary of the baseline conditions relevant to the historic environment. Full discussion of the archaeological and historical background is set out in Appendix 14.6 and the results of the walkover survey undertaken to inform this assessment are presented in Appendix 14.7. All heritage assets and features referred to below are individually recorded within Appendix 14.1, Cultural Heritage Site Gazetteer. The numbering within the Gazetteer is not sequential due to the methodology employed during the walkover survey. All heritage assets and features referred to in the text and within Appendices 14.1, 14.6 and 14.7 are shown on Drawings 14.1-14.3.

14.5.2 Within the Gazetteer, Appendix 14.1, designated heritage assets are identified by their statutory designation, either 'Scheduled Monument' or 'Listed Building'. Individual heritage features within the southern portion of the RAF Skaw (centred Site 3) are identified by 'RAF feature within Scheduled Monument', 'Non-RAF feature within Scheduled Monument' or 'Features excluded from Scheduled Monument' to differentiate between the features which are directly related to the Scheduling, those of which are included within the Scheduled Area and those which have been specifically excluded from the Scheduling.

14.5.3 Features identified as 'Non-RAF feature within Scheduled Monument' relate to features within the Scheduled Area which are not specifically noted as being excluded in the Scheduling but which do not specifically relate to evidence of the construction, use and abandonment of the Chain Home radar station which forms the reason for designation. Individual heritage features within the Scheduled Monument of Inner Skaw (centred Site 2) are identified as 'Feature within Inner Skaw Scheduled Monument' where the feature relates to the specifics of the Inner Skaw Scheduling, or 'RAF feature within Inner Skaw Scheduled Monument', where a feature dating to the Second World War has been identified.

14.5.4 The Proposed Project comprises the following principal elements:

- Launch area at Lamba Ness comprising three launch pads, a satellite tracking station, launch vehicle integration buildings, roadways (largely re-using existing roads), fuel storage and ancillary infrastructure.

14.5.5 The Proposed Project extends across the southern portion of the Scheduled Area of RAF Skaw (centred Site 3). RAF Skaw is the northernmost 20th century Chain Home Radar Station and is composed of two areas, the northern portion is located c. 830 m to the north-east of Skaw and is centred on Site 24, whilst the southern portion is centred on Site 3. Numerous individual features within the southern portion of RAF Skaw have been recorded, including the remains of radar structures, domestic blocks and defensive structures and these are shown on Drawings 14.2a-c.

14.5.6 Inner Skaw (Site 2) Scheduled monument is located immediately north of the Proposed Project. The Proposed Project boundary does not extend within it and no development is proposed within the Scheduled Area. The designated asset comprises the remains of a multiperiod settlement with associated agricultural remains which dates from the Early Historic period onwards.

14.5.7 The Scheduled Monument of St John's Church at Norwick (Site 1) is a multi-period asset which encompasses an Iron Age broch and the remains of a chapel located c. 1.19 km south-west of the Proposed Project.

14.5.8 There are two Listed Buildings (Sites 4 and 6) located within 1km of the Proposed Project. The Banks, Norwick (Site 4), a group of Category C Listed 19th century crofts, are recorded c. 670 m south-west of the Proposed Project. A Category C Listed boat-roofed shed (Site 6) is located c. 740 m north of the Proposed Project.

Geology and topography

14.5.9 According to the British Geological Survey GeoIndex (BGS 2020), the Proposed Project is underlain by Skaw Intrusion, a microgranite, porphyritic igneous bedrock formed approximately 359 to 444 million years ago in the Devonian and Silurian periods. This bedrock is indicative of an environment previously dominated by silica rich magma.

14.5.10 The superficial deposit recorded in the eastern and western portion of the Proposed Project is recorded by the BGS (2020) as Till and Morainic deposits, formed approximately 3 million years ago in the Quaternary period under Ice Age conditions. The central area is underlain by superficial blown sand deposits also formed approximately 3 million years ago in the Quaternary period. In the areas not subject to previous development during the Site's use as an RAF radar station, the ground investigation works have indicated that in general, the deposits encountered consist of peaty topsoil overlying peat, which in turn overlies blueish grey sandy clay. The clay overlies bedrock with varying levels of weathering. The peat across the Site varies in depth from c. 0.15 m to c. 2.75 m, with the deepest deposits being located in the vicinity of Launch Site 2.

14.5.11 The land slopes gently north-eastward. The western boundary is recorded at c.36 m AOD and the land slopes eastward to 1 m AOD and then rises slightly to 9 m AOD at the eastern end of the Proposed Project Site. The land in the south-western corner is recorded at 17 m AOD and slopes north-eastward to 2 m AOD.

Archaeological and Historical Background

Prehistoric

14.5.12 There is evidence of prehistoric activity in Shetland from the Mesolithic period and evidence of activity in Unst from at least the Neolithic period, largely in the form of chambered cairns. An Iron Age settlement which is thought to have been in use for at least 500 years between the late 1st millennium BC and the 1st millennium AD was uncovered between 2004 and 2007 at Sandwick, c.14 km south of the Site, on the south-eastern coast of Unst. Iron Age deposits associated with settlement remains were also recorded as underlying Viking remains at the Broch of Underhoull, on the south-west coast of Unst (Small, 1965).

14.5.13 Details of known prehistoric features within the Proposed Project Site and within the surrounding Study Area are set out in Detailed Archaeological and Historical Background in Appendix 14.6. Prehistoric features, including a possible cairn (Site 9) and a midden (Site 48) have been identified within the Proposed Project site and prehistoric activity is well documented in the surrounding 1 km and in Unst. As such there is judged to be a High potential for prehistoric remains to survive within the Proposed Project site, particularly around the edges of the peninsula and around natural boat landing locations.

Early Historic

14.5.14 Minimal Roman activity is known in the Shetland Islands, although a Roman brooch has been reported at Site 1 which suggests a potential trading relationship with the Romans further south or perhaps evidence of an heirloom. As such the end of the prehistoric period is generally regarded as the 9th century and the arrival of Norse peoples (SIC, 2019).

14.5.15 The Viking invasions started about 800AD and settlement subsequently followed. The Orkenyinga Sagas record Shetland as the northern third of the great earldom of Orkney (SIC, 2019). The etymology of Unst suggests a Norse origin for the name of the island. Unst is believed to have originated in 'Qstr' meaning 'corn stack', however it is argued that the name was converted from the pre-Norse name (Shetland Amenity Trust, n.d.). Norwick to the south-east of the Sites contains 'wick' which is thought to originate from 'Vik', a Norse word for 'bay', referencing the settlement's location.

14.5.16 The Scheduled Monument of Inner Skaw (Site 2) is located immediately north and west of the boundary for the Proposed Project. The Scheduled Area encompasses a series of settlement and agricultural remains dating from the Early Historic period onwards. Further evidence of Early

Historic remains has been encountered in the study area, the details of which are set out in Appendix 14.6.

14.5.17 Given the proximity of Inner Skaw Scheduled Monument (Site 2), which dates from this period, there is judged to be a High potential for hitherto unknown Early Historic remains to survive within the area of the Proposed Project.

Medieval

14.5.18 Shetland was mortgaged to the Scottish crown in 1468 as part of the dowry of Princess Margaret in her marriage to James III of Scotland (SIC, 2019). In 1471, as the Danish struggled to pay Margaret's dowry, Scotland annexed Orkney and Shetland in lieu of the dowry (SIC, 2019). As such, the annexation of Shetland to Scotland in 1471 draws to an end the period of Norse rule and as such acts as the boundary between the Early Historic and medieval period.

14.5.19 Full details of medieval assets and features within the Proposed Project Site and the surrounding Study Area are set out in the Detailed Archaeological and Historical Background in Appendix 14.6. The Proposed Project lies immediately south and east of the Scheduled Area of Inner Skaw (centred Site 2). The Scheduled Area is recorded as containing evidence of continuous settlement and agrarian activities from the Early Historic period onwards.

14.5.20 While there are no further medieval assets and/or features recorded within 1 km of the Proposed Project, post-medieval buildings and farmstead identified within the study area may have had earlier, medieval antecedents. As such there is judged to be a High potential for medieval remains to survive within the area of the Proposed Project; given the proximity to Inner Skaw these would most likely be associated with settlement or agricultural activities.

Post-Medieval

14.5.21 Pre-Ordnance Survey maps tend to be schematic and lack detail, although they give some idea of the nature of settlement. Blaeu's 1654 map depicts the Shetland Islands. In the north-east of Unst, 'Harolswick', to the south of the site, Norwick to the south-east and Saxa Vord, over 1 km to the west of the site are annotated. A pictogram of a church is depicted at each of the settlements recorded by Blaeu (1654) which indicates that each settlement had a chapel or church in the mid-17th century. Whilst the size of each settlement is not record by Blaeu (1654), the number of settlements annotated suggest that the north-eastern area of Unst was well populated in this period.

14.5.22 Moll's 1732 map is not dissimilar to Blaeu's earlier illustration; however, it appears to have been drawn at a larger scale and the settlements in Unst are not annotated, only noted by pictograms of churches.

14.5.23 A map by Preston (1781- not illustrated) records a singular church in the north-east of Unst, which is most likely the Scheduled Church of St John (Site 1), to the east of the Site. Norwick is annotated to the south-east of the site and Lamba Ness, on which the Proposed Project is situated, is labelled. This map is described as a hydrographical survey and was most likely designed to help in the navigation around the Shetland Islands. As such the map was less interested in recording land use or settlement density. However, the map does indicate that the Church of St John (Site 1) must have been a seaward point of interest, and potentially a navigational aid.

14.5.24 The Old Statistical Account of Scotland (OSA) for Unst was recorded in 1793 (Mouat and Barclay, 1793). A map engraved for the OSA (D6/158) annotates Lamba Ness, which appears to be occupied by at least three structures, a relatively large settlement at Norwick with a Chapel (Site 1) and another Kirk to the south (possibly Site 17). Unst is recorded in the OSA as being in the presbytery of Shetland in the late 18th century. Unst is described as having a ragged, and broken coastline with a number of bays and creeks, and Norwick to the south-east of the Proposed Project is noted as being one of the principal bays of Unst. Lamba Ness, where the Proposed Project is situated, is described as the most north-eastern point which has free communication to the North Atlantic Ocean. However, it was recorded that there was no lighthouse in the area in the late 18th century which made fishing and shipping in the area problematic. The OSA notes that Dr Webster recorded the population of Unst as 1,368 in 1755, and the OSA recorded the population in 1793 as 1,988, which indicates a 45% growth in the population in the late 18th century. No proper roads are noted in Unst in 1793. Agriculture is documented as being the main employment type in Unst, largely dominated by black oats, potatoes and green and garden roots, black cattlemen, pigs and sheep, although in the years prior to the publication of the OSA, harsh winters had decreased the sheep population by a third. Fishing is noted as being another form of employment on the island, however the OSA suggests that it was a secondary pursuit in the late 18th century. No mines or quarrying activity was documented in Unst in 1793, and the main source of fuel was peat. Mills in Unst were recorded as being wheel-less, instead being 'tirl'-horizontal mills, two of which (Sites 19 & 20) are recorded within 1 km of the Proposed Project.

14.5.25 Two undated maps, probably dating to the late 18th or early 19th century, one by George Thomas (D23/123) and one of unknown origin (D16/389/112/12), depict the north-eastern area of Unst. Lamba Ness is depicted as a peninsula, and no structures are depicted on the peninsula. However, a group of buildings are depicted on a north-south aligned stream which runs to a beach on the north coast of the peninsula, possibly in the vicinity of Sites 48 and 75 and another group of buildings is depicted in the vicinity of Inner Skaw (Sites 2 & 25). Another building is recorded in the vicinity of Site 61. A north, south aligned boundary is depicted in the vicinity of the western boundary of the Proposed Project on these maps, which may also be a road which originates at The Floggie, the road from Norwick, along the coast to Lamba Ness which extends to the village of Skaw. Buildings are depicted around Skaw, and dispersed buildings, most likely small farmsteads or crofts, are depicted from Haroldswick to Norwick on these maps, although no roads are depicted in this area.

14.5.26 Thomson's 1827 map of Unst depicts the north-eastern coast of Unst. Topographically, an area of high land is depicted in the northern central area of Unst, and another slight area of high land is depicted at the western end of the Lamba Ness peninsula. A chapel labelled on the east coast of Unst is likely the Scheduled St John's Chapel (Site 1).

14.5.27 The New Statistical Account (NSA) for Unst (Ingram et al., 1845) records that the population of Unst was hit by two smallpox outbreaks, due to the lack of inoculations available in Unst, however overall the population was documented as 2,909 persons in 1831, an increase of 43% from the OSA (Mouat et al., 1793). A poor climate in the 5-6 years prior to the NSA being written, is noted as hitting the population as well as impacting on the number of people relying on fishing. Smaller farms than those recorded in the late 19th century further support the move of the population towards fishing over farming. Two thousand acres of arable land are recorded in Unst in 1845, which was organised as an infield, outfield system. Iron stone and limestone quarrying is record in Unst by 1845. A quarry (Site 62), visible on aerial photography taken in 2014 is located within the north-eastern area of the Proposed Project.

14.5.28 Full details of post-medieval assets and features both within the Proposed Project Site and in the Study Area are set out in the Detailed Archaeological and Historical Background presented in Appendix 14.6. This includes further map regression related to the Proposed Project itself. Heritage features comprise farm buildings and houses, crofts, enclosures and land boundaries both on site and in the surrounding study area. The site was clearly located within a post-medieval agricultural landscape. Given this, there is judged to be a High potential for remains associated with the post-medieval occupation and agricultural use of the Proposed Project Site.

Modern

14.5.29 The First World War destroyed the booming herring industry which had supported the population of the Shetland Islands from the post-medieval period. Emigration increased in the 1920s and 1930s which decreased the overall population (SIC, 2019). The Second World War caused a temporary boom on the Shetland Islands as it was utilised as a base for covert and secretive missions between the continent and the British Isles due to the bonds between Shetland and Norway. The 'Shetland Bus' which used fishing boats to support the Norwegian resistance ran from Shetland (SIC, 2019).

14.5.30 Map regression indicates little change on the Proposed Project Site in the early half of 20th century, prior to the development of RAF Skaw (Site 3) on Site. The radar station is the most northerly of the chain home radars of the Second World War. The Scheduled Area (Site 3) is composed of two separate areas, the largest and southern most within the site was the location of the Advanced Chain Home (ACH) and latterly the main Chain Home (CH) radar with the smaller reserve station located c. 855 m north. The Floggie, a route from Norwick northwards, along the coast was straightened, widened, and strengthened in 1940 to facilitate the construction of the radar station (Carle, 2018a).

14.5.31 A detailed history of the construction use and abandonment of RAF Skaw are provided in Appendix 14.6. Based on the presence of RAF Skaw within the Proposed Project boundary and having regard for the detail set out in Appendix 14.6, there is a High potential for further modern remains to survive within the Site. Any remains would most likely be associated with the construction, use and abandonment of RAF Skaw radar station (Site 3).

14.5.32 Modern assets within the study area include a Category C Listed boat-roofed shed (Sites 6 & 64), built in 1940 which is located c. 740 m north of the Proposed Project.

Walkover Survey

14.5.33 A walkover survey of the Site was undertaken between the 21st and 25th July 2020 in dry weather conditions which varied between bright sun and overcast. The weather provided ideal walkover survey conditions, good ground visibility was available and good visibility of the surrounding landscape and seascape was achieved. The walkover survey covered the Proposed Project Site and recorded the extent and condition of previously identified heritage features as well as recording any previously unrecorded features. The full results of the walkover survey are set out in Appendix 14.7; cultural heritage plates referred to in the walkover survey text can be found in Appendix 14.2.

Drone Survey

14.5.34 A drone survey has been undertaken across the Proposed Project Site. The drone survey noted the presence of many upstanding remains previously recorded via the NRHE, SMR and during the walkover survey.

14.5.35 Several linear features, potentially post-medieval field boundaries (Sites 484-486), not visible during the walkover survey were visible from the results of the drone survey. These features have not been directly dated but appear to be similar in form to others identified within the Proposed Project Site (Sites 214-217b, 230 & 434). It is possible that these linear features may be of post-medieval date or older, especially due to the proximity of Inner Skaw (centred Site 2) and the field system identified around Site 75.

14.5.36 A north to south aligned linear feature (Site 484) was identified to the west of Site 85 and a number of potentially interconnecting or overlapping linear features (Site 485) were identified around Site 85, to the east of Site 484. These may be the remains of a field system, similar to that recorded to the west centred Site 216 and the field system record around Site 75.

14.5.37 Another linear feature aligned north north-east to south south-west (Site 486) was identified to the west of Site 288. Historic maps record this area as '*The Garths*' and it is possible that this linear feature is an old field boundary associated with the post-medieval or earlier use of the land.

14.5.38 Two large negative features (482 & 483) were identified east of the CH Transmitter block (Site 85). These appear to be similar in form to the excavated areas identified during the walkover survey (Sites 321, 345,247, 373, 410) and may be additional areas which have been reduced around the CH Transmitter block (Site 85) and mast bases (centred Site 102 & 103) for either; spoil to create the banks and bunds around the CH radar blocks and other earthwork protective defences; or to enable the construction of the steel masts at Sites 102 & 103.

14.5.39 The field system within the Scheduled Inner Skaw (centred Site 2) and the field system around Site 75, a post-medieval stone building, is visible on the drone survey as a larger field system, extending south to the track which bisects the Proposed Project and further east and west, than either the Scheduled extent of Inner Skaw (centred Site 2) or the SMR recorded area around Site 75 indicate. The southern extent of the field system seems to survive in a relatively poor condition, compared to that observed around Site 75 and within Inner Skaw (centred Site 2). No evidence of rig and furrow is visible, and the field systems appear to be similar to the medieval and post-medieval infield, outfield systems.

Results of Ground Investigation Works and Archaeological Watching Brief

14.5.40 Ground investigation (GI) works were undertaken, with SMC, in October and November 2020. GI works were required to inform the design of the Proposed Project and were subject to an archaeological watching brief.

14.5.41 The GI works took place between the 27th October and the 3rd November 2020 and comprised of 304 peat probes, one Russian Core and the excavation of 42 machine dug test pits. Peat probes were sunk away from known archaeological remains and their locations were chosen in consultation with the onsite archaeologist, and they were undertaken in a regular grid pattern. Peat probes recorded the depth of peat across the Site between 0.15 m and 2.75 m in depth.

14.5.42 A singular Russian core was sunk beside TP020. No archaeological remains, buried land surfaces or the potential for environmental proxies were identified.

14.5.43 Test pits were positioned 5m away from all known archaeological features and five tests pits were abandoned due to the proximity of archaeological remains and the difficulty in reaching the proposed locations with a machine. One test pit was abandoned due to wet ground conditions. The probable hiatus of peat development was noted in TP017, a plastic pipe was encountered in the section of TP029 and a brick, denoting the presence of an electrical cable was identified in TP043. No archaeological remains were observed in any of the other excavated test pits. The full report on the results of the archaeological watching brief is included in Appendix 14.8.

Review of Existing Buildings

14.5.44 Aecom has produced a review of the existing buildings on Site and this is contained in Appendix 14.5. The review has considered the current condition of the extant upstanding buildings on site and commented on their condition and stability.

14.5.45 Overall, the review has indicated that there has been significant degradation of the buildings on site since the decommissioning of RAF Skaw. Concrete buildings and features are subject to degradation from weathering and carbonation and the review indicates that the degradation of exposed concrete features, given the location of the Site and the time since abandonment, has likely reached the reinforcement allowing decay.

14.5.46 Of particular note is the safety of the Power House (Site 77). The review indicates that as a result of loss of the roof and internal walls, the external walls are no longer supported at roof level. Large vertical cracks from the ground level are evident on the south-west elevation wall. The review indicates that the Power House is at risk of collapse in high winds.

14.5.47 Also, of note are the roofs of the CH Transmitter, Receiver and Power House (Sites 85, 93 and 111). The review indicates that waterproofing has deteriorated, exposing the roof slab in some areas. This in turn is impacting the surface of the roof and allowing significant deterioration of the concrete and the reinforcements.

14.5.48 Brick structures on Site, including the ACH buildings (Sites 96, 98 and 99), also show signs of deterioration due to weathering and carbonation. Buildings which remain roofed with concrete appear to be in reasonable condition. However, unroofed buildings no longer have roof support and in time will be at risk of collapse in high winds.

Conservation Management Plan (CMP)

14.5.49 A CMP incorporating a Condition Survey Report has been produced for the Skaw radar station and this is contained in Appendix 14.10. The CMP assesses the significance of Skaw radar station, evaluates the issues and opportunities it has and provides a range of conservation policies to guide the future development, preservation, interpretation and use of the site.

14.5.50 The Condition Survey was undertaken by Adams Napier Partnership and David Narro Associates to inform the CMP. Despite lack of any recent meaningful maintenance, the exposure of the Site and the widely acknowledged issues with deterioration of Second World War structures the Condition Survey has revealed the majority to be generally in a fair and stable condition, albeit some structures, including the Power House (Site 77), are in poor condition Detailed descriptions of each of the buildings surveyed is presented in the Condition Survey report

14.6 Receptors Brought Forward for Assessment

14.6.1 All designated heritage assets including individual features therein and all non-designated heritage features within the Proposed Project boundary are brought forward for assessment to allow for consideration of the potential for direct effects upon them resulting from operation of the Proposed Project.

14.6.2 All designated heritage assets within the study area for the Proposed Project were found to lie within the zone of theoretical visibility and, as such, all have been brought forward for assessment to allow for consideration of the potential for setting impacts upon these designated heritage assets as a result of the operation of the Proposed Project.

14.7 Standard Mitigation

14.7.1 It is acknowledged that operation of the Proposed Project will have a direct impact upon a number of features within the Scheduled RAF Skaw (Site 3). Further, and despite the extensive survey undertaken to inform this assessment, there may be potential for further previously unrecorded archaeological features within the Site.

Conservation Management Plan (CMP)

14.7.2 The CMP (appendix 14.10) represents a commitment to the ongoing management and maintenance of the Skaw radar station site during operation of the Proposed Project and presents a range of broad policies to allow for this commitment to be met.

14.7.3 An outline of proposed conservation works, and an assessment of their priority is provided within the CMP. In making these management, maintenance and repair recommendations, the aim has been to retain the surviving buildings and structures in a safe and manageable condition whilst respecting and preserving their significance.

14.7.4 In addition, a programme of annual inspection and maintenance will be carried out on all structures to control unwanted vegetation growth, stabilise loose brickwork and make good any localised areas of failing mortar, with regular inspections formalized to identify any defects.

Vibration and Terrain Monitoring

14.7.5 A review of the upstanding buildings on Site has been undertaken to inform the planning application, to identify any structures which are already in a state of compromise and therefore may be more vulnerable to direct impacts resulting from vibrations from satellite launches. The results of this are outlined in Appendix 14.5. The mitigation measures to be implemented to monitor and protect these buildings during the operational phase are outlined below.

Vibration Modelling

14.7.6 HES requested that consideration be given to the potential for the operation of the Proposed Project to directly impact upon standing structures within the Proposed Project Site. A review of the condition and stability of the upstanding buildings on Site has therefore been undertaken to establish, insofar as possible, a baseline structural stability for these features. Modelling ground and structural vibration is complex and dependent on the unique material properties of each element and its respective boundary conditions, the maintenance condition of the structure, and the incident sound wave characteristics. These complexities have resulted in structural damage criteria for launch vehicle environmental reviews that are largely based on findings from anecdotal evidence and static horizontal rocket testing. Thus, while it is acknowledged that future research is needed, the damage claim criteria used in the Shetland noise study (AEE Chapter 8) represents the best available dataset regarding the potential for structural damage resulting from launch noise – as the findings are based on actual rocket noise and community surveys over a large number of events. This indicates that the potential for structural damage is likely to be low.

14.7.7 For structures of historical significance, typical practice is to document conditions prior, during, and after a launch event. In extremely sensitive cases, measurements on individual structural elements of interest may be performed during launch for comparison with established damage criteria. On this basis vibration monitoring will be undertaken on Sites 96, 98, 99 and 111 in the vicinity of Launch Site 3 and Site 85 in the vicinity of Launch Site 2 and Site 90 between Launch Sites 2 and 3. Further, baseline data will be gathered prior to launches commencing on Site and monitoring will initially take place during launches to ensure that there is no damage to structures as a result of the operation of the Proposed Project. A programme of regular monitoring will be established thereafter and be dependent upon the results of initial monitoring. Where monitoring identifies the potential for structural damage, HES and the Shetland Regional Archaeologist will be informed immediately and further mitigation strategies will be discussed, agreed and implemented to prevent damage to any affected structures.

14.8 Potential Effects

Direct effects

14.8.1 Ongoing launches and works associated with the operational phase of the Proposed Project have the potential to directly impact the heritage features within the Proposed Project Site. Vibrations from proposed launches have the potential to cause structural damage to upstanding features.

14.8.2 Several upstanding buildings within the Proposed Project Site have been identified as part of review of existing structures presented in Appendix 14.5, as being in various states of degradation. These include the unroofed brick structures at Sites 90, 96, 98 and 99, the roofs of the CH buildings (Sites 85, 93 and 111) and the Power House (Site 77), which have been structurally compromised to some extent. A detailed study of these structures is also presented in the Condition Survey Report in Appendix 14.10.

14.8.3 These reviews have established a baseline structural stability for these features insofar as possible, as set out in Appendix 14.5 and 14.10. However, the extent to which they might suffer impacts as a result of the vibration associated with launches is difficult to assess at this stage. This is because modelling ground and structural vibration is complex and dependent on the unique material properties of each element and its respective boundary conditions, the maintenance condition of the structure, and the incident sound wave characteristics. These complexities have resulted in structural damage criteria for launch vehicle environmental reviews that largely based on findings from anecdotal evidence and static horizontal rocket testing. Thus, while it is acknowledged that future research is needed, the damage claim criteria used in the Shetland noise study (Chapter 8) represents the best available dataset regarding the potential for structural damage resulting from launch noise – as the findings are based on actual rocket noise and community surveys over a large number of events. This indicates that the potential for structural damage is likely to be low. However, as per the above, the potential magnitude of impact cannot be accurately identified at this stage. Mitigation measures outlined in Section 14.7 will ensure that any potential for impact is identified early and mitigation is put in place to ensure that no significant effects arise.

Setting effects

14.8.4 Zone of Theoretical Visibility (ZTV) analysis and mapping have been used to identify those designated assets that could potentially be affected by changes to their settings during the operational phase of the Proposed Project and all designated heritage assets within the study area have been carried forward for assessment. The detailed assessments have included a review of the contextual characteristics of each asset using information drawn from their designation documentation, supplemented by observations on the morphology, condition and character of each asset and the nature of their settings made during site visits undertaken in July 2020.

14.8.5 The qualitative setting assessment for each asset considered is set out below. The assessment follows HES guidance on setting assessment (HES, 2016, updated 2020). Having identified the assets which could be affected, this section defines the setting of each heritage asset and how this contributes to the understanding, appreciation and experience of the assets. This is followed by consideration of the impact of the Proposed Project on the setting of the asset in question and consideration as to whether the integrity of the assets' setting would be adversely affected. Sensitivity of the assets to changes to their settings, the magnitude of impact and the resulting level of effect are given in line with the methodology set out in Section 14.4.

St John's Church, remains of, Norwick (Site 1)

14.8.6 St John's Church (Site 1) comprises the remains of a former church which survives as the turf covered footings of the walls of the nave. The asset is thought to be located on the site of a former Iron Age broch. The chancel has been built over with a later memorial. The Statement of National Importance associated with the Scheduling states that:

> '*The monument is of national importance as the remains of a simple pre-Reformation parish church, with the potential to provide information about medieval church architecture and parish organisation. It was probably constructed at about the time that Shetland was passing from Danish to Scottish rule*.' (HES, 2020a).

14.8.7 The current setting of the church is defined by the post-medieval and modern burial ground, which currently occupies the site, and the surrounding residential properties of the village of Norwick. The church sits on elevated ground above Nor Wick bay which lies to the north-east and there are views down to the associated beach, across Nor Wick and to the Lamba Ness peninsula to the north. The ground rises to the south to the summit of the Hill of Clibberswick. The current surroundings of the asset contribute to an understanding of it as a place of worship for the immediately surrounding settlement, within which it forms a moderately prominent landmark. Salvage excavations in 2003 found evidence for Viking and Iron Age settlement at the site, though not necessarily a broch –as local tradition holds. The setting, on a knoll above, but with access to the sea at the beach and Nor Wick bay, and the natural defensive cliffs of Lamba Ness and the Hill of Clibberswick to the north and south respectively contribute to an understanding and appreciation of reasons for selecting this site for settlement in earlier periods. On this basis St John's Church is judged to have a high relative sensitivity to changes to its setting.

14.8.8 Elements of the Proposed Project would be visible, above the cliffs of Lamba Ness, from St John's Church. In particular, the buildings associated with the Assembly and Storage Area and some security fencing around these would be visible. A small portion of two of the dishes associated with the Satellite Tracking Area and the upper portions of the Integration Hangar would also be visible. The Integration Hanger would be visible behind the CH/S Power House (Site 93). Launch vehicles and lightning towers required for launches from the Proposed Project would also be visible for a limited amount of time. However, only one launch pad would be utilised at any given time and these items of infrastructure would only be visible on launch days.

14.8.9 While the elements of the Proposed Project described above would be visible, they would only occupy a small proportion of the view of Lamba Ness when viewed from the church; and they would not obscure or detract from the ability to understand, appreciate or experience the relationship between the church and the settlement of Norwick, Nor Wick bay or the surrounding and inherently defensive coastline. In addition, launch events may be audible but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially impact upon the setting of the church.

14.8.10 On this basis the Proposed Project is judged to constitute an alteration to the setting of the church but one which would not affect an ability to understand the contribution that setting makes to the asset's overall significance. The magnitude of impact is predicted to be low and this would result in a minor level of effect, resulting in **no significant effects**.

Inner Skaw, houses and field system (Site 2)

14.8.11 Inner Skaw, houses and field system (Site 2) is a Scheduled Monument which comprises the remains of a series of farmhouses, the earliest of which may be of early Norse date, and their associated field system(s). The monument is visible as a series of stone wall and building foundations or footings with some upstanding walls remaining. The field systems extend, within the Scheduled area to the north, north-east and north-west of the structural remains and also appear to extend further east and south beyond the Scheduled Inner Skaw area, as shown by the walkover survey and the drone survey (see Site 75 extents). The Statement of National Importance associated with the Scheduling states that:

> '*The monument is of national importance as a remarkably fine example of a long-lived agricultural settlement, which may have its roots in the period immediately after the Norse settlement of Shetland in the ninth century AD, and which has been re-used on several occasions up to the nineteenth century.*
>
> *The settlement's importance is enhanced by the adjacent field systems, which represent several episodes of use, and although the earliest visible remains are probably Medieval rather than Norse, there is the potential for further investigation to clarify this and the whole settlement sequence*. (HES, 2020b).

14.8.12 The Scheduled Monument sits on land either side of a burn which flows north from the centre of the peninsula, down to the Sand of Inner Skaw. The buildings are primarily located in the south of the Scheduled Area and to the west of the burn. The field systems extend down slope to the coast and to the burn, where they then rise upslope on the eastern side of the burn, where the cultivation remains are particularly well defined (Plate 145). An ashy midden (Site 48) was found within the Scheduled Area and excavated in 2001, and numerous artefacts including steatite vessels, pottery and stone tools were recovered. The Scheduled remains are separated from land to the south by a post and wire fence which largely runs along the access road associated with the remains of RAF Skaw, the post and wire fence also dog legs north on the eastern side of the burn cutting across cultivation remains and the Scheduled Area.

14.8.13 The agricultural nature of the settlement and field systems is discernible in the current setting of the asset, even with the juxtaposition with later Second World War remains. The relationship between the building remains and the visible cultivation remains contained with the field system are particularly important in understanding the nature and longevity of settlement at this site, along with the asset's relationship to the burn which it straddles and the sea, at Inner Skaw Sands, to the north. The placement of the settlement, and indeed its longevity, would likely have been predicated on access to suitable agricultural land as well as other resources which could be exploited, as represented by the burn and easy access to the coast. The asset is considered to be of high relative sensitivity to changes which would affect the ability to understand the relationship between its built and agricultural elements and which would diminish the ability to appreciate its relationship to the important topographic and landscape features noted here, namely the burn, sloping land and Inner Skaw Sands beach and inlet.

14.8.14 Viewpoint 1 indicates that the infrastructure associated with the Satellite Tracking would be prominent in views towards the south-east, truncating views in this direction. A portion of the Satellite Tracking Station would also be located in part of the field system outwith Inner Skaw Scheduled Area but within RAF Skaw Scheduled Area and would be located c. 73 m to the south-east of the boundary of the Inner Skaw Scheduled Area. Launch Site 1 would be located c. 250 m to the east and Launch Sites 2 and 3 would be visible behind this. The Integration Hangar would also be visible as a large new structure in views eastwards. While not indicated on Viewpoint 1, buildings associated with the Assembly and Storage Area are likely to be partially visible on higher ground to the west from the western edges of the Scheduled Area.

14.8.15 The Launch Sites and Integration Hangar would all be located outwith the designated area of Inner Skaw though it would be located in the wider associated field system and they further would not affect the relationship between the built and agricultural remains and the topographical features of the burn, the sloping land to the north and the beach at Inner Skaw Sands. However, the proximity and nature of these elements of the Proposed Project to the remains at Inner Skaw are such that they would change the current setting of the asset. Similar impacts upon the setting of Inner Skaw would have been experienced during the operational period of RAF Skaw, given the extent of former buildings and masts at the Site. On balance and given the above, and particularly as a result of the proposed construction of the security fencing and portions of the Satellite Tracking Station within the wider and less well-preserved portions of the field system, the predicted magnitude of impact would be medium. This would result in a moderate level of effect which is equivalent to a **likely significant effect**. As elements of the monument would largely remain legible in terms of their function and relationship to one another, it is considered that this effect would not adversely affect the integrity of the asset's setting.

Skaw, radar station (RAF Skaw) (Site 3)

14.8.16 The history and the features of RAF Skaw are outlined in Section 14.5, Appendix 14.6 and Appendix 14.7 and, as such, are not repeated in full here. A key reason for the asset's designation is the fact that it has survived as a coherent monument representing a largely intact RAF complex. The statement of National Importance makes particular reference to the asset as providing a '*complete example of the technical, support and domestic buildings and structures necessary to provide an early warning reporting function*'. And further states that '*the loss of the monument would significantly diminish our future ability to appreciate and understand the scale of the efforts employed on the home front in the defence of Britain*' (HES, 2020a).

14.8.17 As it currently stands the buildings, structures and individual features contained within the bounds of the RAF Skaw and their function and historical relationship to one another are easily interpreted and understood by an informed observer. Taken together the features within the boundaries of RAF Skaw allow for a detailed understanding of the construction and operation of the site as a chain home radar base during the Second World War. The topographical setting of RAF Skaw, on a peninsula with cliffs to the coastline on three sides, also contributes to an understanding of the strategic placement of the base in a location which provided a naturally defendable position from the sea, in a location between mainland Europe and the Atlantic. It is of high relative sensitivity to changes within its boundaries.

14.8.18 The continued operation of new infrastructure in the vicinity of these locations will result in a number of new features within and amongst the RAF structures and these will impact upon the character and setting of the asset and the ability to understand how the base functioned as a whole.

14.8.19 Cultural Heritage Viewpoint 2 (Appendix 14.4) was chosen as the location offers a good vista over the eastern portion of RAF Skaw from which the CH Transmitter (Site 85), the CH/S Power House and the CH Receiver Block (Site 111) are clearly visible along with the Power House (Site 77) and a number of ACH buildings (Sites 96 & 98). The field system associated with Inner Skaw (Site 2) is also clearly visible from this location. While a clear understanding of the above RAF features and the relationship to one another requires closure examination and consideration of some of the less visible features to allow for a true understanding of construction, use and abandonment of RAF Skaw; the viewpoint does allow for an understanding of the strategic location of the site on the defensible Lamba Ness peninsula and for an understanding of the scale and distribution of the RAF remains. The visualisation indicates that Launch Site 1 is likely to obscure views of the CH Transmitter (Site 85). Views of the CH/S Power House and CH Receiver along with views of the northern ACH buildings will remain possible but they will be juxtaposed with the Integration Hangar and Launch Site 3 respectively. The Satellite Tracking Area would be seen in the foreground of views of the Power House. The interspersion of the Proposed Project amongst the RAF remains would diminish the ability to understand the relationship of the RAF remains to one another from this location. The strategic nature of the topographic position of the site would remain clear.

14.8.20 Cultural Heritage Viewpoint 3 (Appendix 14.4) was chosen for similar reasons to Viewpoint 1, in that it provides an overview of RAF Skaw from the east, looking west and inland over the CH/S Power House (Site 93) and the nearby guard hut (Site 142). From this position the remains of the CH masts (Sites 102 & 103) are visible with the top of the CH Transmitter building (Site 85) beyond. The Power House (Site 77) and another small guard hut (Site 84; due to be lost) are visible further to the west. The visualisation indicates that the Integration Hangar building would obscure the most westerly RAF buildings currently visible in this view and it would form a prominent new feature, located adjacent to the CH/S Power House. It will obscure views westward of much of the access road and it would remove portions of the remains of southern most of the two masts (Site 103). The security fencing and infrastructure associated with Launch Site 2 would remove the remains of the mast at Site 102 and would obscure views of the CH Transmitter (Site 85). When operational, prior to launch, the launch vehicles at Launch Sites 1 and 2 would form high vertical features. Though it is noted in the case of Launch Site 2 that this may allow for an understanding of some elements of the former character of the Site when it was an operational RAF facility; as the Launch Site would be in the location of a former mast (Site 102) and when operational the Launch Site would reintroduce a tall vertical feature in this location. However, overall, the interspersion of the Proposed Project amongst the RAF remains would diminish the ability to understand the relationship of the RAF remains to one another from this location and the some of the ability to understand how the site operated.

14.8.21 Cultural Heritage Viewpoint 4 (Appendix 14.4) was taken from the north-east corner of the CH Transmitter (Site 85) which is one of the most prominent and imposing remaining RAF buildings on the Site. It is of concrete construction with double blast walls, the outer of which has been banked up with earthen bunding. The view looks towards the remains of one of the transmitter masts (Site 102) associated with the transmitter. Launch Site 2 is proposed to be constructed at the location of the former mast and, as the visualisation indicates, security fencing and infrastructure associated with the Launch Site would be visible in close proximity. The loss of the remains of the mast footings (discussed in terms of direct effects above) would have an impact upon the contextual understanding of the CH Transmitter as directly associated features would be removed. Though it is noted in the case of Launch Site 2 that this may allow for some understanding of the former character of the Site when it was an operational RAF facility; as the Launch Site would reintroduce a tall vertical feature in this former mast location. As such it may allow, for short periods and with proper interpretation, for the appreciation of the height and location of the lost mast and its relationship to Site 85.

14.8.22 Cultural Heritage Viewpoint 5 (Appendix 14.4) is taken from near the gun and crew shelter (Site 74) and looks north-eastward. It marks the probable location of a strategic surveillance position with billets (Site 79) in the foreground and an air raid shelter (Site 78) located further to the south-east. The position is elevated above land further east along the peninsula and located near to the cliff top offering views over Nor Wick bay and out to sea in a south-easterly direction. The location also affords views over much of the radar infrastructure associated with RAF Skaw with several guard huts and the Power House (Site 77) visible along the access road and the CH Transmitter (Site 85), the CH/S Power House (Site 93) and the CH Receiver (Site 111) all clearly visible north-east and east. Elements of the early accommodation block (centred around Site 83 & 109) are also visible directly to the east and elements of the ACH infrastructure are visible on the northern coast of the end of Lamba Ness peninsula. As such this viewpoint offers a vantage point which illustrates the contextual relationship between several of the main elements of RAF Skaw.

14.8.23 The visualisation indicates that the Integration Hangar would be a prominent feature in views from this location and that while the CH Transmitter, CH/S Power House and the CH Receiver would still be visible they would be backed by infrastructure associated with Launch Sites 2 and 3 and in the case of the CH/S Power House the Integration Hangar would be seen in a dominant position adjacent to the power house. As the new infrastructure is proposed to be interspersed with the remains of the RAF infrastructure and given the extent and the scale of the Proposed Project, the contextual relationships between and functional associations of individual elements of RAF Skaw would be more difficult to appreciate.

14.8.24 Cultural Heritage Viewpoint 6 (Appendix 14.4) was taken from the track (85hh) looking towards the CH Transmitter (Site 85) with the remains of the transmitter masts (Sites 102 & 103) in the background. It, like Viewpoint 5, was chosen to demonstrate the contextual and functional relationship between particular elements of the CH Transmitter infrastructure. The large cuttings (Sites 410, 392, 479 and 402) are also apparent in the slope to the east of the track and leading up towards the mast locations. Elements of the ACH infrastructure and the CH Receiver (Site 111) are visible in the background. This viewpoint in particular allows for understanding, by an informed observer, as to the extent of construction work that was required to establish RAF Skaw. The construction of the access track between Launch Site 2 and the Integration Hangar would remove much of the remains of the large cuttings which appear to be associated with the transmitter masts and would result not only in an inability to understand them as coherent features but would also prevent an understanding of their relationship to the former masts. Security fencing and infrastructure associated with operations at Launch Site 2 would sit above the CH Transmitter and the satellite in preparation for launch would form a prominent feature behind it. Though it is noted that when in launch preparation the vertical feature would be located in the historical location of the former vertical mast. The Integration Hangar will largely prevent views of the RAF features located at the extreme eastern extent of the peninsula from this location. The Proposed Project when considered from this viewpoint will diminish the ability to understand the relationship between individual elements of the CH Transmitter operations.

14.8.25 Cultural Heritage Viewpoint 7 (Appendix 14.4) is included at the request of the Shetland Regional Archaeologist and has been taken from the top of the northern bank surrounding the CH/S Power House (Site 93) looking north towards the CH Transmitter (Site 85) and the former masts (Sites 102 & 103). Given the proximity of the Integration Hangar to the CH/S Power House it would obscure all views in this direction from the CH/S Power House.

14.8.26 Cultural Heritage Viewpoint 8 (Appendix 14.4) was also included at the request of the Shetland Regional Archaeologist and has been taken from the north-east corner of the bank surrounding the CH Receiver block (Site 111). The security fencing along with the infrastructure associated with Launch Site 3 will largely prohibit views of the topography of the peninsula and the cliff edge in this view.

14.8.27 Consideration has also been given to how the Proposed Project might impact upon the setting and character of RAF Skaw in terms of its relationship to the northern element of the Scheduled Area which represents the reserve radar station. Currently the large buildings associated with the main site at RAF Skaw (the CH Receiver and the CH/S Power House) are clearly visible from the northern portion of the Scheduled Monument. LVIA viewpoint 1-1 (Drawing 13.3.1.1) indicates the launch sites and the Integration Hangar would be seen in this view but that the CH Receiver and Power House would remain obvious features.

14.8.28 Operation of the Proposed Project will result in the continued use of new structures interspersed amongst the RAF remains which adversely affect the ability of to understand the contextual relationships and associations of the individual features. Given the above, the Proposed Project would impact upon the intactness and the coherence of the Scheduled Monument and the impact upon its character and setting is judged to be high. The level of effect would be **major** and result in

likely significant effects. The integrity of the asset's setting would be adversely affected as a result of the diminishment of the coherence of the monument and intrinsic and contextual characteristics of the asset would be adversely affected.

14.8.29 HES have also requested specific comment on how the Proposed Project might impact upon the associative characteristics and social value of the asset. Associative characteristics can relate to how the asset is perceived and valued by people today. As noted above, associative value for RAF Skaw can be measured, in part, by the interest shown in the monument by local people and by military enthusiasts. This is evident in previous exhibitions held at Unst Heritage Centre and in the publication of a blog on the History of RAF Skaw. However, it would seem that most of that value resides in the historical associations of the asset which are well recorded. It is also the case that these characteristics can be appreciated remotely/indirectly through interactions with representations of and information regarding the asset. On this basis, while there is likely to be an adverse effect on associative characteristics there is potential to mitigate these effects, and indeed to enhance appreciation of the asset, through the proposed Interpretation Strategy set out below and in Appendix 14.9.

Norwick, The Banks, Including Cottage, Outbuilding, Ruin, Boundary and Sea Walls (Site 4)

14.8.30 The Banks (Site 4) comprise a group of buildings including a house, cottage, outbuilding and sea walls along with a ruin. The group is Listed together at Category C and the main house dates to the later 19th Century. The Listing description states the following in the Statement of Special Interest:

> *The Banks was originally known as The Bod. Despite the installation of modern glazing, this group retains its traditional appearance characterised by low-pitched tarred roofs and thick rubble walls. The contrast of the startling white walls with the black tarred roofs enhances the picturesque quality of this group in its dramatic and rocky setting.* (HES, 2020c).

14.8.31 The group sits to the north of the beach at Nor Wick bay and its main elevations face south and east across the beach and out to the bay. The land rises steeply behind (to the north) of the buildings up The Cliffs towards Braehead and eventually the Ward of Norwick and extends east along the cliffs of the Lamba Ness landform (Plate 146; and visible in LVIA viewpoint 1.6 (Drawing 13.3.1.6). As the Statement of Special Interest notes the buildings' setting against the beach and the rocky cliffs contributes to an understanding of its placement. That being a relatively protected location for a croft in an otherwise rocky and potentially harsh location. The Statement of Special Interest also references the picturesque qualities of the buildings assigning significance to their aesthetic qualities. The buildings' setting primarily relates to the Nor Wick bay and cliff side setting and is less sensitive to changes beyond this setting. On balance the group is judged to have a medium relative sensitivity to changes to its setting, as the setting makes an overall moderate contribution to an understanding, appreciation and experience of the buildings.

14.8.32 Elements of the Proposed Project would be visible, largely in views of The Banks when approached along the beach road from the south and from further way, along the B9087 travelling towards Norwick (LVIA viewpoint 1.6 (Drawing 13.3.1.6)). Views of the Proposed Project from the buildings themselves would be more limited given their orientation and steeply rising cliffs to the north and north-east. In views of The Banks from the south infrastructure associated with Storage and Assembly Area would be visible above and behind the Listed Buildings as would limited elements of the Satellite Tracking equipment. Launch vehicles at all three Launch Sites would be visible when preparing for launch but infrastructure associated with the Launch Sites would not. While these elements would be visible, they would not obscure or detract from the ability to understand, appreciate or experience the relationship between The Banks and Nor Wick bay or the surrounding coastline. The relationship between The Banks and the beach, bay and cliffs would not be obscured. In addition, launch events may be audible at The Banks, but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially contribute to the impact upon the setting of The Banks.

14.8.33 On this basis, the Proposed Project would constitute an alteration to the setting of The Banks but one which would not affect the ability to understand the contribution that setting makes to its significance. The magnitude of impact is predicted to be low and this would result in a minor level of effect, resulting in **no significant effects**.

Papil, Valsgarth, Including Outbuildings and Walls (Site 5)

14.8.34 The croft buildings at Papil, Valsgarth (Site 5) are Category B Listed and include a house and outbuildings located within improved fields with their main elevation facing south towards the bay at Harold's Wick (Plates 147 & 148). The land slopes up behind the buildings towards the rise on which Saxa Vord Resort is located and to the summit of the Hill of Clibberswick to the east. The Statement of Special Interest states:

'*A particularly fine example of a larger crofthouse and outbuildings in little-altered condition and sporting an excellent glazed timber porch of the type that was once a common characteristic of buildings in Unst. The building may have been altered to its present form by settlers from Sutherland in the 1870s, accounting for its larger size and quality of construction. This picturesque group is prominently sited near the road.'* (HES, 2020d)

The setting of Papil, such that it contributes to an understanding, appreciation and experience of the asset, primarily relates to its location on the road, the surrounding improved agricultural fields and its relationship with Harold's Wick Bay to the south. These features contribute to an understanding and appreciation of the croft's siting in a location where agricultural resources could be readily exploited and, in a location, which provided access to good transport and communication links. It is sensitive to changes within this defined setting and less sensitive to changes in the wider landscape. On balance it is considered to be of medium relative sensitivity to changes to its setting, as its setting makes an overall moderate contribution to an understanding, appreciation and experience of it.

14.8.35 The Proposed Project would not be discernible from Papil due to intervening topography and built structures. None of the elements of the Proposed Project would affect the ability to understand the relationship of Papil to its setting as described above. Launch events may be audible, but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially contribute to any impact upon the setting of Papil.

14.8.36 As such the magnitude of impact upon the setting of Papil by the Proposed Project would be negligible at most. The level of effect would be neutral and result in **no significant effects**.

Skaw, Boat-Roofed Shed (Site 6)

14.8.37 Skaw, Boat-Roofed Shed (Site 6) is designated as a Category C Listed Building. It dates to c. 1940 and forms an outbuilding to Skaw Cottage (Plate 149). It is set at the opening of the deeply incised valley associated with the Burn of Skaw where it opens onto Skaw beach to the east. The boat-roofed shed is orientated with its main elevation to the south-east towards the road and the beach. The ground rises to the north of the shed towards Skaw and rises steeply to the south on the other side of Skaw Burn (Plate 150). The Statement of Special Interest implies that the majority of the assets cultural value lies in its architectural and historical interest and in its rarity.

> *The boat used for this shed was one of 2 lifeboats from the British steamer Sea Venture, which was sunk by a German submarine on 20th October 1939. Once a fairly common sight in Shetland, these boat-roofed sheds are becoming increasingly rare.* (HES, 2020e).

14.8.38 The setting of the boat-roofed shed is largely limited to the Wick of Skaw and the settlement at Skaw cottage and the wider landscape does not contribute to an understanding, appreciation or experience of it, though it does have wider contextual value as noted in the Statement of Special Interest. On this basis it is considered to have low relative sensitivity to changes to its wider setting.

14.8.39 None of the Proposed Project would be visible from the boat-roofed shed, with the possible exception of upper elements of launch vehicles when in preparation for launch. Launch events may be audible, but these impacts would be short-lived and number no more than 30 per year. As such they are not considered to materially contribute to any impact upon the setting of the boat-roofed shed at Skaw. A precautionary negligible magnitude of impact is predicted which would result in a neutral level effect, which would give rise to **no significant effects**.

14.9 Additional Mitigation and Enhancement

14.9.1 It is acknowledged that operation of the Proposed Project will have a major and significant effect upon RAF Skaw and the integrity of its setting. There will also be a moderate and significant effect upon the setting of Inner Skaw. As such, it proposed to offer compensatory measures aimed at enhancing the understanding and appreciation of RAF Skaw and Inner Skaw, which would include the opportunity for enhancement of the assets' associated characteristics.

14.9.2 The Proposed Project offers the opportunity for investment into the protection and interpretation of the remains at RAF Skaw. As the review of existing buildings (see Appendix 14.5) has shown, many of the buildings would benefit from regular monitoring to prevent further degradation and loss. The detailed policies outlined in the CMP in Appendix 14.10 along with the regular monitoring of structural integrity recommended in Appendix 14.5, will ensure that further deterioration can be mitigated through intervention or, if a building is structurally unsound such that it is beyond repair ensure that it can be adequately recorded prior to any required demolition which may need to take place on H&S grounds. As such, the Proposed Project may be able to help limit further loss from degradation through weathering and carbonation and, where loss cannot be minimised, ensure preservation by record.

14.9.3 In addition to the potential for increased care of the features within RAF Skaw, interpretative measures could be used to enhance the associative characteristics of the asset, making it more readily understandable and accessible to a wider audience. This will ensure that the surviving elements of RAF Skaw are secured for the understanding and enjoyment of present and future generations (HES, 2019b). The programme would aim to make the knowledge about RAF Skaw and its significance accessible to the widest audience possible (Scottish Government , 2014) . In line with Our Place in Time: The Historic Environment Strategy for Scotland the mitigation package would seek to '*enhance participation through encouraging access to and interpretation and understanding of the significance*' of RAF Skaw and Inner Skaw (ibid, 24),

14.9.4 To achieve this aim, it is envisaged that the mitigation package will include, as noted in part above, the following:

- **Implementation of the Conservation Management Plan** - to ensure that the significance of the remaining features of RAF Skaw and Inner Skaw are not impacted upon during the operation of the Proposed Project and to ensure that any works undertaken to facilitate interpretation and access are done in such a way as to avoid further impact upon RAF Skaw and Inner Skaw.
- **Interpretation Strategy** - to enhance understanding, appreciation and experience of RAF Skaw and Inner Skaw. This will include some or all of the following with the agreement of the Shetland Islands Council and relevant consultees:
  - On-site interpretation hubs for both RAF Skaw and Inner Skaw.
  - School packs for dissemination to Shetland schools e.g., to fit in with Second World War topics (RAF Skaw) and Viking's topics (Inner Skaw) for both primary and secondary students.
  - A mobile-friendly website (standalone or linked to the Shetland Space Centre Website) which could include 3D models, VR/AR tour, history of the base including its context in the wider Chain Home Radar network.
  - Potential re-use of one of the RAF Skaw buildings as an on-site interpretation centre with standing and/or rotating exhibits subject to further structural assessment.

14.9.5 Appendix 14.9 sets out these proposals in greater detail.

14.10 Residual Effects

14.10.1 There is potential for residual direct effects during the operational phase as a result of the vibration associated with launches. Mitigation has been put forward in Section 14.7 to ensure that upstanding historic structures will be monitored during the operational period and that this will ensure that the potential for further impacts are identified prior to any harm being experienced and that steps are taken to mitigate this. This will ensure that any residual direct operational effects are negligible and there are **no likely significant effects**.

14.10.2 The predicted residual impacts on the settings and character of designated heritage assets will be the same as assessed for the operational effects. However, as set out in Section 14.9 and Appendix 14.9, compensatory measures are proposed.

14.11 Cumulative Assessment

14.11.1 Cumulative effects can be either inter-project or intra-project effects.

14.11.2 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. Due to the location of the Proposed Project on the north coast of Unst, the most northerly of the Shetland Islands, it is considered that there are no potential inter-project cumulative effects as there are no other existing or proposed developments in the Study Area for cultural heritage and archaeology.

14.11.3 Shetland Islands Council was contacted during the planning application stage of the Proposed Project and confirmed that there are no committed development or infrastructure projects on the Island which should be considered in the assessment.

14.11.4 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. Given that with the exception of noise and vibration, none of the other environmental topics considered impact directly on archaeology and cultural heritage, and the fact that noise and vibration is not considered to result in significant effects and that only one launch will occur at any given time and launches will be phased with time enough for the EZI to return fully to its baseline state between launches, it is considered that there is no potential for additive or intra-project cumulative effects.

14.12 Summary

14.12.1 This chapter identifies the archaeological and cultural heritage significance of the Proposed Project Site and assesses the potential for direct and settings effects on cultural heritage assets and features resulting from the operation of the Proposed Project. This chapter also identifies measures that should be taken to mitigate predicted adverse effects.

14.12.2 Major and significant direct and setting effects are predicted upon the Scheduled remains of RAF Skaw (Site 3) resulting from the operation of the Proposed Project. This would result from the removal of a number of features associated with the construction, use and abandonment of RAF Skaw and, from the construction of new and large-scale structures associated the Proposed Project. The impacts would adversely affect the integrity of the asset's setting.

14.12.3 Moderate and significant setting effects are expected on the Inner Skaw Scheduled Monument (Site 2) as a result of the Proposed Project. There would be no direct effects upon the Scheduled Monument. The relationship of the component parts of the asset to each other and to its surroundings would still largely be legible and so the integrity of the asset's setting would not be adversely affected.

14.12.4 Significant effects upon RAF Skaw and on the setting of Inner Skaw Scheduled Monuments are acknowledged and a programme of compensatory measures are proposed to enhance the understanding and appreciation of these designated assets and provide increased access to them through implementation of a CMP and Interpretation Strategy.

14.12.5 The CMP represents a commitment to the ongoing management and maintenance of the Skaw radar station site during operation of the Proposed Project and presents a range of broad policies to allow for this commitment to be met. An outline of proposed conservation works and an assessment of their priority is provided within the CMP. In making these management, maintenance and repair recommendations, the aim has been to retain the surviving buildings and structures in a safe and manageable condition whilst respecting and preserving their significance. In addition, a programme of annual inspection and maintenance will be carried out on all structures to control unwanted vegetation growth, stabilise loose brickwork and make good any localised areas of failing mortar, with regular inspections formalized to identify any defects

14.12.6 In terms of residual effects, vibration monitoring will take place during the operational phase to ensure that the potential for any impact upon upstanding remains resulting from vibration during launch events is identified early and that further steps are taken to avoid or minimise any harm. As such any direct residual effects resulting from vibration during the operational phase are predicted to be negligible and as such no likely significant effects are predicted. There will however be major and significant residual setting effects upon RAF Skaw and moderate and significant residual setting effects upon Inner Skaw.

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SA6/432- Undated- Map showing proposed road to Northdale, Haroldswick, Unst

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Appendix 3 -

Appendix 4.1 GHG Calculations

Orbex PRIME GHG Calculations v0.1 03/02/2025

1. Launch

LPG mass	5474	kg
Emission Factor	2.9394	kgCO2e/kg
Ancillary other GHG precursors	0	kg
CO2e	**16090**	kg

2. Transport

Road distance	Loads	Miles	km	Laden EF (kgCO2e/km)	Unladen EF (kgCO2e/km)	kgCO2e
Heavy duty vehicles				50% laden artic (all)	50% laden artic (all)	
Forres to Aberdeen	8	77	124	0.83506	0.83506	1657
Lerwick to Toft	8	28	45	0.83506	0.83506	602
Ulsta to Gutcher	8	18	29	0.83506	0.83506	387
Belmont to Skaw	8	15	24	0.83506	0.83506	323
Tankers				Tanker full EF (kgCO2e/km)	Tanker empty EF (tCO2e/km)	
Grangemouth to Aberdeen	2	132	213	1.07433	0.74987	775
Lerwick to Toft	2	28	45	1.07433	0.74987	164
Ulsta to Gutcher	2	18	29	1.07433	0.74987	106
Belmont to Skaw	2	15	24	1.07433	0.74987	88
					Road subtotal	**4103**

Ferry distance	Laden	nm	km	Container / Ferry EF (kgCO2e/tonne km)	Payload inc. vehicles (t)	kgCO2e
Aberdeen to Lerwick		224	415	0.06105	159.5	4040
Toft to Ulsta		2.9	5	0.06105	159.5	52
Gutcher to Belmont		1.25	2	0.06105	159.5	23
	Unladen			0.06105		
Gutcher to Belmont		1.25	2	0.06105	143.5	20
Toft to Ulsta		2.9	5	0.06105	143.5	47
Aberdeen to Lerwick		224	415	0.06105	143.5	3634
					Sea subtotal	**7816**
					Transport total	**12240**

	Loads	Tonnes per load	
Stages	3	2	
Ground equipt	5	2	
40' container	3	4	
20' container	5	2.3	
Truck weight unlade	8	15	
Net weight shipped			39.5
Gross weight			159.5
Weight of delivery			16
Weight of return trip			143.5

LOx tankers	1
LPG Tankers	1

Number of laden cryo		1	
Cryo extra fuel need (%)		50%	
Uplift from cryo tankers		**321**	kgCO2e

Grand total per launch	**28.33**	tCO2e

Distances from Google Maps and ports.com
Factors from 2024 Defra GHG Conversion Factors

Appendix 5.1a SaxaVord Spaceport Breeding Bird Survey Report

Appendix 5.1 Shetland Space Centre Breeding Bird Survey Non-confidential version

Alba Ecology Ltd.

2020

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Introduction

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the 'Shetland Space Centre' (SSC). As part of this proposal, Alba Ecology Ltd. was commissioned in 2017 to conduct breeding bird surveys targeted around the proposed planning application boundary on Unst. The proposed development involves the following three elements:

- Proposed Launch Site – a launch area at Lamba Ness comprising three launch pads, a satellite tracking station, launch vehicle integration buildings, roadways (largely re-using existing roads), fuel storage and ancillary infrastructure;
- Proposed Launch and Range Control Centre (LRCC) at Saxa Vord; and
- Proposed New Section of Access Road – a short stretch of new road at Northdale.

Aim

To inform the proposed development in Unst, Shetland a breeding bird survey with four main stages was undertaken.

- Survey site selection;
- Survey methodology agreed with Scottish Natural Heritage (SNH, now NatureScot);
- Breeding bird surveys of potentially affected areas; and
- Breeding bird survey report.

Survey methodology consultation

On 06/02/18 SNH was approached and consulted on the scope and scale of ecological and ornithological surveys to support a planning application for a satellite launch site at Lamba Ness, Unst by Alan Farningham of Farningham Planning Ltd. Jonathan Swale of SNH responded on 16/02/18 stating that "*Our advice on the survey work proposed by Alba Ecology and on the scope of any environmental impact assessment is set out below. As we don't yet have full details of the proposed development and operation, this is offered on the basis of the information provided to date and without prejudice to further consideration when more details become available*".

Jonathan Swale reported that *"the environmental assessment should consider the impacts on breeding birds of operation of the launch site, as well as its construction, so surveys should cover the area likely to be affected. Rocket launches could cause disturbance over a large area, but without information on the expected noise levels we aren't able to advise on the likely extent of disturbance nor on the area that should be surveyed to carry out the impact assessment. It may be necessary to assess possible impacts on seabirds within Hermaness, Saxa Vord and Valla Field SPA but this will not require additional survey work as we have recent data that can be used".*

Consideration of whimbrels within the Hill of Colvadale and Sobul SSSI was also recommended for potential works near that designated site. However, this area did not feature in the planning application boundary and so is not reported on. SNH advised that the cliffs around Lamba Ness were likely to support nesting fulmar, shag, black guillemot and possibly gulls and that these species should therefore be surveyed too.

Methods

Survey site selection

Assessing the potential effects of disturbance on bird species is a complex issue which varies depending on the type of disturbance (e.g. routine/predictable verses unusual/unexpected), topography, vegetation and the behaviour/tolerance of the bird species and even different individuals within species. Therefore, identifying a one-size-fits-all Study Area over which all potentially affected breeding bird species could be surveyed is challenging. Consequently, this was considered in a number of different ways, which are outlined below.

In Scotland, all wild birds are legally protected, but some species are considered more sensitive to human disturbance than others and they are specially protected under European, UK and Scottish legislation. Disturbance can have adverse effects on birds' breeding success, e.g. through chilling, overheating and desiccation of eggs or chicks and starvation of chicks and ultimately the abandonment of a territory. Therefore, the distance over which disturbance might potentially occur was considered particularly important when determining the breeding bird Study Area.

Very little work has taken place on the impact of disturbance on most of the species potentially present within habitats on north Unst. However, for two of these species, some guidance has been published on the distances at which they are likely to be affected by disturbance. In Ruddock and Whitfield (2007), 80% of expert opinions estimated static disturbance occurred at 500-750 m for nesting and chick-rearing red-throated divers and expert opinion suggested 'safe working distances' could exceed 500m. Ruddock and Whitfield (2007) suggested that breeding red-throated divers are sensitive to human activity, visual disturbance and sudden noise events over relatively large distances (up to 500m). Evidence from Viking Wind Farm studies in Shetland indicated that some individuals (perhaps habituated) appear to tolerate moderate levels of disturbance in some situations. The size of waterbodies also has an impact; breeding birds are more easily disturbed and fly from smaller nesting lochans (where they presumably feel more vulnerable) than larger nesting lochs, where they have the ability to swim away, without taking flight.

Similarly, breeding merlins are considered sensitive to human activity, visual disturbance and sudden noise events over large distances (up to 500 m) (Ruddock and Whitfield 2007) particularly prior to egg laying and during incubation in Shetland (the late Mark Chapman, *pers comm.*). However, individual merlins appear to tolerate moderate levels of disturbance in some situations. For example, merlins appear to be able to nest relatively close to public roads in Shetland, where regular (predictable) disturbance occurs.

Based on Ruddock and Whitfield (2007), there is some evidence and expert opinion that sudden noise events up to 500-75 0m away from two potentially affected species could be detrimental. Based on this, it might have been possible to recommend a 1 km survey buffer around the launch facilities. However, none of the potentially affected target species had been monitored in relation to sudden, relatively short-duration loud noise events of the magnitude of a satellite launch. Furthermore, at the time of Pre-app scoping (2018) and determination of the ornithological Study Area, there was no information on predicted noise levels available. Consequently, this 1 km survey buffer was not considered an adequate basis on which determine the size of the breeding bird Study Area.

EIA best practice guidance (and the EIA Regulations) requires consideration of worse-case and best-case scenarios and the subsequent reporting of *likely* effects. There is no standard guidance on potential disturbance (and so survey) distances for satellite launch facilities compared to other large-scale developments e.g. wind farms. At the time of pre-app scoping, it was not possible, based on previous experience or published information, to determine what *likely* might be in the context of this development and so a precautionary approach to determining the size of the Study Area was considered and adopted.

During pre-app scoping, there was no planning application boundary, only an indicative boundary area. As a result, an arbitrary, but very large precautionary Study Area, was selected for breeding bird surveys. According to expert opinion (Ruddock and Whitfield, 2007), the greatest distance any UK species was predicted to be affected by human induced disturbance was 1.5-2 km (for breeding golden eagle – which does not occur on Unst). Given the lack of any empirical evidence or guidance, it was decided that doubling the greatest possible disturbance distance for any UK breeding bird, i.e. a 4 km buffer from the proposed launch facility, was a legitimate precautionary basis on which to proceed with breeding bird surveys. Consequently, the size of the breeding bird Study Area (EIA Report Drawing 6.1) was much larger than the final planning application boundary area and it was centred on indicative launch site locations provided by the Applicant during Pre-app scoping discussions in 2018.

Breeding bird survey methodology

Reconnaissance

A preliminary site visit by Dr Peter Cosgrove in late autumn 2017 determined that the proposed development area was predominantly open coastal/upland habitat characterised by peatland, grassland, cliffs and plus some old military buildings.

The principal land use of the Study Area was sheep grazing through crofting and common grazings. There was potential for several specially protected bird species to be present so breeding bird surveys were conducted under a SNH Schedule 1 licence.

Photo 1. Typical view of the satellite launch facility part of Study Area, taken from Ward of Norwick, overlooking Swartling and Inner Skaw east towards The Garths and Lamba Ness.

Moorland breeding bird surveys

The modified Brown and Shepherd (1993) Moorland Breeding Bird survey is the standard survey technique for moorland/upland breeding birds (Gilbert *et al*., 1998) and is described in the SNH online guidance (e.g. SNH 2005; and subsequent updates). The Brown and Shepherd methodology is based on a constant search method involving spending 25 minutes in each 500 m × 50 0m quadrant, within the study area. This equates to spending 100 minutes for every km^2. Each quadrant was walked to ensure that all parts were approached to within 100m. At regular intervals, the surveyor paused, scanned the area for species and listened out for calls and songs. All registrations were marked on a 1:25,000 scale map using British Trust for Ornithology symbols with a note of the species activity. The main habitat was defined as open moorland so this survey technique was used across all parts of the Study Area. However, there were some wetter/marshy areas in the Study Area which were observed from the nearest edge.

Population estimates of birds in the Study Area were derived by comparing the summary maps for each of the breeding survey visits. Registrations/territories plotted during each period were considered to be separate from one another if more than approximately 500m apart for larger species, 300 m in the case of smaller species. If there was any doubt about whether more than one pair of birds was present in an area, the surveyor would sit quietly nearby and observe the behaviour, gender and number of birds present as per Brown and Shepherd's 1993 survey methodology. When compiling figures of breeding birds, the approximate central location of all registrations recorded from different visits is used to identify a notional territory centre (the species 'dot' on the relevant figure) where a nest was not discovered. Surveys were undertaken in 2018 and 2019 as per consultation agreement with SNH.

Breeding raptor surveys

SNH provides clear guidance in relation to raptor sensitivities and survey effort (2005; and subsequent updates). The only regularly occurring and widespread breeding raptor in Shetland is merlin, although both kestrel and peregrine are occasionally recorded breeding in Shetland and in 2018-2019 sparrowhawk was recorded breeding in Shetland for the first time (Shetland Bird Club, 2020). Breeding raptor surveys were undertaken to determine the location of any breeding merlins within the Study Area using standardised merlin survey methods (e.g. as per Hardey *et al*., 2013). These surveys also covered potential breeding habitats of kestrel and peregrine, were they to be present. Surveys were undertaken in 2018 and 2019 as per agreement with SNH.

Breeding red-throated diver surveys

Searches were made for breeding red-throated divers within the Study Area. Following SNH guidance, searches for nesting red-throated divers were undertaken on all potentially suitable waterbodies within the Study Area. The waterbodies were visited at least twice during the breeding season if nothing was present. However, if the water body was occupied, sites were revisited later in the breeding season to determine nest locations and breeding success. Surveys were undertaken in 2018 and 2019 as per agreement with SNH.

Black guillemot

Black guillemots breed on the coast, preferentially near shallow water and their nests are typically in natural holes, crevices, caves and boulder beaches (Gilbert *et al*., 1998). Black guillemots usually nest in pairs or in small groups scattered along the coast and so surveys should therefore aim to cover sections of coastline rather than discrete 'colonies'. The standard survey methodology for this species highlights that '*nest-sites are difficult to count with any accuracy because of their scattered distribution and inaccessibility. Carefully timed counts of individual adults provide the most accurate* [survey] *method*' (Gilbert *et al*., 1998).

The black guillemot survey methodology requires two survey visits a week or more apart, preferably during the first three weeks of April, although counts later in April or early May also acceptable (Gilbert *et al*., 1998). Two survey visits were undertaken in April 2018 and 2019 (as per agreement with SNH). The surveys were conducted from first light until particular defined cliff reaches were surveyed, during suitable, calm and clear weather conditions (as per Gilbert *et al*., 1998).

The surveyor was specifically required to make a note of any substantial cliff reaches where land-based surveys were not possible due inaccessibility or health and safety considerations. As it turned out, most of the potentially suitable black guillemot breeding habitat could be surveyed from land (which SNH advised would likely be the case) and so surveys proceeded on that basis. The surveyor, who was familiar with the Study Area, moved along the coast counting all black guillemots on the sea, within about 300 m of the shore and any that were on land. Repeat counts were also undertaken in the afternoon for some reaches for comparative purposes.

Cliff nesting seabirds

Other cliff nesting seabirds were potentially present and required survey: fulmar, shag, guillemot, razorbill, puffin and possibly gulls. The standard method for surveying cliff nesting seabirds requires the number of individual adult birds per visit recorded (also known as max number of Apparently Occupied Nests (AON) from any one visit), which can be summed, and a mean produced over different survey visits undertaken. The standard survey guidance recommends between two to five survey visits. Given the nature of the Study Area, with no low tide beach below the steep cliffs, boat-based counts were undertaken between the eastern edge of the Hermaness, Saxa Vord and Valla Field SPA (approximately Virdik) and The Nev (southeast of Hill of Clibberswick), as per agreement with SNH. No climbing down a cliff to count breeding birds was undertaken.

Puffins are difficult to census due to their use of burrows, often in inaccessible locations. The most reliable way they are monitored is by long-term monitoring of Apparently Occupied Burrows (AOB) from sample areas, rarely possible in Shetland due to the steep and inaccessible nature of the terrain (Mitchell *et al.,* 20014). When these burrows cannot be accessed, as was the case within the Study Area, the standard survey methodology is to count individual birds on land, which provides a rough estimate of numbers present. However, in Shetland such previous counts have taken place at the same time as the optimal count for other cliff nesting seabirds in June, when it is known that non breeders also attend colonies and so can inflate numbers of presumed breeders present (Owen *et al.,* 2018).

The razorbill, guillemot and shag standard survey methods recommend surveys in the first three weeks of June in north of Scotland in ‘normal years’ (June or July for gannets, June for fulmar, early-mid June for kittiwake). Consequently, boat-based surveys were scheduled for the first three weeks of June given the main species likely to be present on the cliffs (and well-spaced across these 3 weeks). The two main sources of seabird survey guidance were followed: Gilbert *et al*., (1998) and JNCC Seabird Monitoring Handbook (Walsh *et al*., 2011).

Following this best practice guidance, the following measures were undertaken:

- Suitable health and safety measures were enacted, and the boat was operated by an experienced and trained skipper and life jackets were worn at all times.
- The boat was manoeuvred a suitable distance offshore for surveying to ensure that count position was not close enough to disturb the cliff nesting seabirds.
- For ease of counting, each area of cliff was defined into distinct units for monitoring and recording purposes. These were marked on a map to aid recording purposes.
- Counts were undertaken during the day between 0900 and 1600.
- Counts were replicated, by two highly experienced ornithological surveyors (David Cooper and Brydon Thomason) at the same time.
- The first and third boat-based trips were counted from south to north and the second from north to south in an attempt to reduce any potential 'time of day' bias.
- Foggy and/or wet and windy conditions were avoided. Surveys were planned for, and undertaken on, calm days with good visibility.
- Any parts of the cliff survey area that were not visible for survey were noted.

Further methodological detail on how each seabird species was counted is provided within the JNCC Seabird Monitoring Handbook (Walsh *et al*., 2011). These survey methods and proposed personnel were discussed and agreed with Glenn Tyler at SNH (in a phone call on 24/05/18). Glen Tyler agreed that this approach was suitable and that three-separate boat-based surveys spread across the first three weeks of June during suitable weather conditions was standard and '*sounded ideal*', given the information available at the time. Surveys were undertaken in 2018 as per agreement with SNH.

During data sharing with SNH in 2020 it became apparent that existing bird data for the SPA did not exist for the whole Hermaness, Saxa Vord and Valla Field SPA area. The SPA extends to Virdik but only the marine extension – it does not include the cliffs, which is the only section SNH monitors. Consequently, a gap in cliff nesting seabird data for the area between Virdik and Ura was identified. Fortuitously, this data gap was identified in May 2020, allowing boat-based seabird surveys to be organised for the relevant section of cliff in June 2020, which also coincided with the relaxation of COVID-19 restrictions for outdoor work. The same surveyors who undertook the 2018 boat-based seabird surveys conducted three boat-based seabird surveys between Virdik and Ura in June 2020.

Results

The Study Area was surveyed under SNH Schedule 1 licence for breeding birds in 2018 and 2019 by David Cooper. David Cooper and Brydon Thomason undertook boat-based seabird counts in 2018 and 2020. In 2020 David Cooper surveyed the Application Boundary during the breeding season to inform summer survey visits by SSC staff and other non-ornithological surveyors e.g. archaeologists. Both David Cooper and Brydon Thomason are highly experienced and locally based ornithologists and used the relevant standard breeding bird survey methods during suitable weather conditions.

A total of 135 bird species were recorded in the Study Area during 2018 and 2019 breeding bird surveys. For full list of species recorded, see Appendix 1 to this report; this report focusses on potential target species requiring consideration in the context of the proposed development.

Target species are considered individually below:

Whooper swan *Cygnus cygnus*

Amber List, Schedule 1, Annex 1 species. No evidence of breeding in the Study Area.

A single adult was seen in flight, flying east over Millfield on 21st April 2018. No whooper swans were recorded during 2019 surveys.

Barnacle goose *Branta leucopsis*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A flock of five were seen at Lamba Ness on 7th May 2018. A flock of ten were seen in flight, flying northwest over Saxa Vord hill on the 10th May 2018. A singleton was seen at Lamba

Ness on the 9th June 2018. A pair was seen at Hill of Clibberswick and Millfield on the 9th June 2018 but on no other dates. No Barnacle geese were recorded during 2019 surveys.

Long-tailed duck *Clangula hyemalis*

Schedule 1 species. No evidence of breeding in the Study Area.

A single drake in summer plumage was seen at Skaw throughout June 2018. No records of long-tailed duck during 2019 surveys. In all but three years since 1970, the species has been recorded into at least June in Shetland. In many years, occasional singletons have been seen in July and August, but there has never been any suggestion of breeding (Pennington *et al*., 2004).

Quail *Coturnix coturnix*

Amber List, Schedule 1 species. Evidence of potential breeding in the Study Area.

No birds heard or seen in 2018. Two records of singing birds heard on territory during June 2019, but not further evidence of potential breeding was recorded.

Red-throated diver *Gavia stellata*

Amber List, Schedule 1, Annex 1 species. Evidence of multiple pairs breeding in the Study Area.

Two breeding attempts in the Study Area in 2018 and 2019 (EIA Report Confidential Drawing 1).

Numerous encounters were logged across the whole site including at Lamba Ness, Norwick and Skaw, involving display flights and typical noisy aerial territorial disputes seen throughout both summer breeding seasons.

Black-throated diver *Gavia arctica*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single adult in summer plumage was seen at Lamba Ness and Norwick on the 1st June 2018. No records of black-throated diver were recorded during 2019 surveys.

Great northern diver *Gavia immer*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

Numerous encounters logged on the sea in 2018 including at Lamba Ness, Norwick and Skaw spanning the months April to June, with a maximum of three individuals together seen at Lamba Ness in April. A lone individual was seen in Norwick in June in summer plumage.

Great northern divers were recorded each month between April and July in Norwick Bay in 2019.

Black guillemot *Ceppus grylle*

Two black guillemot surveys were undertaken in both 2018 and 2019. In 2018, the first was on 10-12th April 2018 and the second on 18-20th April 2018. In 2019, the first was on 11-13th April and the second on 28-30th April 2019. The locations of black guillemots are presented in EIA Report Drawing 6.3. The maximum count in 2018 was 84 black guillemots with 101 individuals in 2019.

Cliff nesting seabirds

The summary results in Table 1 refer to three boat-based counts undertaken on 13th, 17th and 29th of June 2018. These surveys covered the coast/cliffs from Virdik, east and southwards down to The Nev (southeast of Hill of Clibberswick). EIA Report Drawings 6.4-6.9 present individual seabird counts in relation to the distance from proposed launch sites.

Table 1. Boat-based seabird cliff counts, Virdik to The Nev, Northeast Unst, June 2018

Species	AON 13/06/18	AON 17/06/18	AON 29/06/18
Shag *Phalacrocorax aristotelis*	55	42	42
Fulmar *Fulmarus glacialis*	3,460	3,895	4,330
Kittiwake *Rissa tridactyla*	53	55	55
Great black-backed gull *Larus marinus*	2	1	1
Guillemot *Uria aalge**	48	80	62
Razorbill *Alca torda**	6	11	8
Puffin *Fratercula arctica**	18	49	41

*Total number of individual adults on land recorded – not AON.

The summary results in Table 2 refer to three boat-based counts undertaken on 10th, 13th and 24th June 2020. These surveys covered the coast/cliffs from Virdik, west to Ura (immediately south of The Noup).

Table 2. Boat-based seabird cliff counts, Virdik to Ura, Northeast Unst, June 2020

Species	AON 10/06/20	AON 13/06/20	AON 24/06/20
Shag	22	25	26
Fulmar	2,495	2,601	2,657
Kittiwake	0	0	0
Great black-backed gull	5	6	6
Herring gull *Larus argentatus*	5	5	4
Guillemot*	9	17	20
Razorbill*	2	4	0
Puffin*	76	37	38

*Total number of individual adults on land recorded – not AON.

Black kite *Milvus migrans*

Annex 1 species. No evidence of breeding in the Study Area.

No records of black kite during 2018 surveys. Single record of a black kite in April 2019 at Battles Kirk, Northwick.

White-tailed eagle *Haliaeetus albicilla*

Red List, Schedule 1 species. No evidence of breeding in the Study Area.

No records of white-tailed eagle during 2018 surveys. Two records of a single individual in May 2019 in Norwick and Ward of Norwick.

Marsh harrier *Circus aeruginosus*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single immature male was seen at Norwick on the 24th April 2018. Three records of marsh harrier in April 2019 in Skaw, with a single female recorded in June 2019 at Northdale.

Merlin *Falco columbarius*

Amber List, Schedule 1, Annex 1 species. Evidence of breeding probably near to the Study Area.

One nearby successful breeding attempt in 2018. A brood of three fledged recorded around Northdale. Despite searching, no merlin nest was recorded within the Study Area and it is not known where the fledged brood came from.

One nearby successful breeding attempt in 2019. A female with fledged juveniles was recorded between Skaw and Inner Skaw. Despite searching, no merlin nest was recorded within the Study Area and it is not known where the fledged brood came from.

Peregrine *Falco peregrinus*

Schedule 1, Annex 1 species. No evidence of breeding in the Study Area.

A single female was seen at Hill of Clibberswick, Norwick and Swartling on 25th May 2018. A total of three single individuals were recorded during 2019 breeding season surveys between months of April and June in Skaw and Ward of Norwick.

Crane *Grus grus*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single individual was seen at Feall on the 20th April 2018 and in flight over Millfield on the 21st April 2018. No records of common crane during 2019 surveys.

Ringed plover *Charadrius hiaticula*

Red List species. Evidence of multiple pairs breeding in the Study Area.

Nine breeding pairs were recorded in 2018 and ten breeding pairs recorded in 2019 (EIA Report Drawing 6.10). Most of the pairs were found at Skaw, Lamba Ness and Norwick.

Golden plover *Pluvialis apricaria*

Amber List, Annex 1 species. Evidence of multiple pairs breeding in the Study Area.

Seven breeding pairs were recorded in 2018 and 13 pairs in 2019 in the Study Area (EIA Report Drawing 6.12). Breeding pairs were distributed throughout the Study Area including at Saxa Vord, Sothers Field, Northdale, Housi Field, Hill of Clibberswick and Swartling.

Whimbrel *Numenius phaeopus*

Red List, Schedule 1 species. Evidence of multiple pairs breeding in the Study Area.

There were five breeding territories in 2018 and four in 2019 (EIA Report Confidential Drawing 2).

Curlew *Numenius arquata*

Red List species. Evidence of multiple pairs breeding in the Study Area.

There were circa.16 breeding territories in 2018 and circa 13 in 2019 (EIA Report Drawing 6.14). Given the distances breeding curlews can move, it is possible that some territories have been double-counted and without colour ringing it is not possible to be certain. Nevertheless, in areas where multiple territories have been plotted close together e.g. Norwick Meadows, there was direct evidence of multiple pairs being present within a relatively small area.

Dunlin *Calidris alpine*

Amber List, Annex 1 race (*C. a. schinzii*). Evidence of breeding in the Study Area.

Five breeding territories were recorded in 2018 and four breeding territories recorded in 2019 (EIA Report Drawing 6.16). Breeding territories were located in areas including Saxa Vord hill, Southers Field, Skaw, Lamba Ness and Housi Field.

Black-tailed godwit *Limosa limosa*

Red List, Schedule 1 species. No evidence of breeding in the Study Area.

A single individual was recorded in suitable breeding habitat, but no evidence of breeding was recorded.

Greenshank *Tringa nebularia*

Amber List, Schedule 1 species. No evidence of breeding in the Study Area.

A single individual was seen along the coast at Wick of Skaw in June 2019. No records of greenshank during 2018 surveys.

Wood sandpiper *Tringa glareola*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single individual was seen at Millfield on the 30th July 2018. No records of wood sandpiper during 2019 surveys.

Arctic skua *Stercorarius parasiticus*

Red List species. Evidence of multiple pairs breeding in the Study Area.

Five pairs of arctic skua recorded breeding in the Study Area in 2018 and 2019 (EIA Report Drawing 6.19). Pairs occupied territories both years in areas including Hill of Clibberswick, Ward of Norwick and Inner Skaw.

Great skua *Stercorarius skua*

Amber List. Highly variable numbers of great skua were recorded during surveys breeding in the Study Area, reflecting the social nature of this species.

Large numbers of non-breeding great skua can hold territory in apparently suitable breeding habitats, making accurate estimates of actual number breeding difficult and with a high degree of uncertainty. It is considered that the number of breeding pairs within the Study Area is likely to be in the low tens, with breeding birds mainly concentrated over 3 km away from the nearest launch pad (EIA Report Drawing 6.21). Great skua numbers were concentrated around Saxa Vord hill e.g. with minimum 17 nests recorded in June 2018 and groups of presumed non-breeders numbering up to 90 individuals. Additionally, within the 3 km to 4 km buffer, smaller numbers of great skua were recorded at Sothers Field and Housi Field.

Sandwich tern *Sterna sandvicensis*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

A single individual was seen offshore at both Norwick and Skaw on five dates from the 31st March 2018 until the 16th July 2018. No records of sandwich tern during 2019 surveys.

Common tern *Sterna hirundo*

Amber List, Annex 1 species. No evidence of breeding in the Study Area.

The first returning individual was noted at Norwick on the 8th May 2018. Whilst there were then multiple sightings typically of single individuals at Haroldswick and Norwick throughout the summer breeding was never proven. In 2019, individuals were recorded in Wick of Skaw in May and July, but breeding was never proven.

Arctic tern *Sterna paradisaea*

Amber List, Annex 1 species. Multiple pairs breeding in the Study Area.

Several small breeding colonies were present within the Study Area (EIA Report Drawing 6.18) with one pair on Hill of Clibberswick in 2018, two pairs in 2018 and three pairs in 2019 on Norwick beach and six pairs in 2018 and ten pairs in 2019 at Skaw.

Red-backed shrike *Lanius collurio*

Red List, Schedule 1, Annex 1 species. No evidence of breeding in the Study Area.

A female was present at Haroldswick on 26th May 2018. A male was present at Inner Skaw and Swartling on 28th and 29th May 2018. A pair were present (the male was singing) at Northdale for a few days from the 28th May 2018. Three records of red-backed shrike were recorded in 2019, a female in May at Clibberswick, a female in June at Inner Skaw and two females in Northdale in June.

Black redstart *Phoenicurus ochruros*

Schedule 1 species. No evidence of breeding in the Study Area.

Single record of a black redstart at Saxa Vord in April 2019. No records of black redstart during 2019 surveys.

Bluethroat *Luscinia svecica*

Annex 1 species. No evidence of breeding in the Study Area.

A single male was singing at Millfield on 11-12th May 2018 and a single was recorded in May 2019. A single male was present at Valyie and Norwick beach on the 14-15th May 2018.

DISCUSSION

Scottish Planning Policy requires that the presence (or potential presence) of legally protected bird species such as Schedule 1 and Annex 1 species is factored into the planning and design of development proposals, and that any impacts on such protected species are fully considered prior to the determination of planning applications.

There is direct evidence from the Study Area of potentially sensitive and specially protected target bird species breeding within, and adjacent to, the proposed planning application boundary (Table 3) and so these need to be considered further in relation to the proposed development.

Table 3. Regularly recorded, potentially sensitive and specially protected breeding birds (2018-2020) within 4 km of SSC launch sites (approximately between Ura and The Nev).

Species	Within 0.5km of launch sites	0.5-1km of launch sites	1-2km of launch sites	2-3km of launch sites	3-4km of launch sites
Red-throated diver pairs	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 1 2019 = 0	2018 = 1 2019 = 2
Black guillemot individuals	2018 = 14 2019 = 13	2018 = 8 2019 = 12	2018 = 27 2019 = 25	2018 = 25 2019 = 26	2018 = 10 2019 = 25
Puffin individuals	2018 = 2	2018 = 6	2018 = 27	2018 & 2020 = 23	2018 & 2020 = 67*
Guillemot individuals	2018 = 0	2018 = 0	2018 = 27	2018 & 2020 = 20	2018 & 2020 = 53*
Razorbill individuals	2018 = 0	2018 = 0	2018 = 0	2018 & 2020 = 2	2018 & 2020 = 13*
Shag AON	2018 = 1	2018 = 0	2018 = 5	2018 & 2020 = 24	2018 & 2020 = 51*
Kittiwake AON	2018 = 0	2018 = 0	2018 = 50	2018 & 2020 = 0	2018 & 2020 = 5*
Great black-backed gull AON	2018 = 0	2018 = 0	2018 = 2	2018 & 2020 = 2	2018 & 2020 = 3*
Herring gull AON	2018 = 0	2018 = 0	2018 = 0	2018 & 2020 = 2	2018 & 2020 = 3*
Fulmar AON	2018 = 430	2018 = 740	2018 = 1,465	2018 & 2020 = 2,645	2018 & 2020 = 1,707*
Ringed plover pairs	2018 = 3 2019 = 3	2018 = 0 2019 = 0	2018 = 4 2019 = 5	2018 = 2 2019 = 1	2018 = 0 2019 = 1
Golden plover pairs	2018 = 0 2019 = 1	2018 = 0 2019 = 0	2018 = 2 2019 = 3	2018 = 1 2019 = 5	2018 = 4 2019 = 4
Whimbrel pairs	2018 = 1 2019 = 1	2018 = 1 2019 = 1	2018 = 1 2019 = 1	2018 = 2 2019 = 1	2018 = 0 2019 = 0
Curlew pairs	2018 = 0 2019 = 1	2018 = 0 2019 = 0	2018 = 3 2019 = 2	2018 = 5 2019 = 5	2018 = 8 2019 = 5
Dunlin pairs	2018 = 0 2019 = 1	2018 = 0 2019 = 0	2018 = 2 2019 = 2	2018 = 1 2019 = 0	2018 = 2 2019 = 1
Red-necked phalarope nests	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 1 2019 = 1	2018 = 0 2019 = 0	2018 = 0 2019 = 0
Arctic skua pairs	2018 = 0 2019 = 0	2018 = 1 2019 = 1	2018 = 1 2019 = 2	2018 = 3 2019 = 2	2018 = 0 2019 = 0
Arctic tern pairs	2018 = 0 2019 = 0	2018 = 0 2019 = 0	2018 = 8 2019 = 13	2018 = 1 2019 = 0	2018 = 0 2019 = 0

*Does not include a very small part of the SPA i.e. from Ura northwards to the Luig, the ca. 4km Study Area boundary.

Note, the individual cliff nesting seabirds recorded between Ura and The Nev are considered 'wider countryside species' and not part of the nearby SPA.

Without doubt, potentially sensitive and specially protected breeding birds could be adversely affected by the proposed satellite launch facility and so a Breeding Birds Protection Plan will be required to be implemented. At the time of writing this report (July 2020) there was no information on likely noise levels from the launch facility. Consideration of potential impacts of satellite launches will be considered within the Environmental Impact Assessment Report (EIA Report). In the meantime, all bird figures/drawings produced have 0.5km, 1 km, 2 km, 3 km and 4 km buffers illustrated to help estimate distances from the proposed launch facilities.

The magnitude of potential effects from the proposed Saxa Vord and Northdale road extension areas is considered likely to be typical of any standard type of construction development and will be considered as such within the EIA Report.

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APPENDIX 1 – BIRD SPECIES RECORDED IN SCC STUDY AREA APRIL-JULY 2018/19

1. Mute swan, *Cygnus olor*
2. Whooper swan, *Cygnus cygnus*
3. Pink-footed goose, *Anser brachyrhynchus*
4. White-fronted goose, *Anser albifrons*
5. Greylag goose, *Anser anser*
6. Canada goose, *Branta canadensis*
7. Barnacle goose, *Branta leucopsis*

8. Shelduck, *Tadorna tadorna*
9. Wigeon, *Anas penelope*
10. Teal, *Anas crecca*
11. Green-winged teal, *Anas carolinensis*
12. Mallard, *Anas platyrhynchos*
13. Pintail, *Anas acuta*
14. Shoveler, *Anas clypeata*
15. Eider, *Somateria mollissima*
16. Long-tailed duck, *Clangula hyemalis*
17. Common scoter, *Melanitta nigra*
18. Red-breasted merganser, *Mergus serrator*
19. Goosander, *Mergus merganser*
20. Red grouse, *Lagopus lagopus*
21. Quail, *Coturnix coturnix*
22. White-billed diver, *Gavia adamsii*
23. Red-throated diver, *Gavia stellata*
24. Black-throated diver, *Gavia arctica*
25. Great Northern diver, *Gavia immer*
26. Slavonian grebe *Podiceps auritus*
27. Fulmar, *Fulmarus glacialis*
28. Manx shearwater, *Puffinus puffinus*
29. Shag, *Phalacrocorax aristotelis*
30. Grey heron, *Ardea cinerea*
31. Black kite*, Milvus migrans*
32. White-tailed eagle, *Haliaeetus albicilla*
33. Marsh harrier*, Circus aeruginosus*
34. Hen harrier, *Circus cyaneus*
35. Sparrowhawk, *Accipiter nisus*
36. Osprey*, Pandion haliaetus*
37. Kestrel, *Falco tinnunculus*
38. Merlin*, Falco columbarius*
39. Peregrine, *Falco peregrinus*
40. Water rail*, Rallus aquaticus*
41. Moorhen*, Gallinula chloropus*
42. Coot*, Fulica atra*
43. Crane, *Grus grus*
44. Oystercatcher, *Haematopus ostralegus*
45. Ringed plover, *Charadrius hiaticula*
46. Golden plover, *Pluvialis apricaria*
47. Lapwing, *Vanellus vanellus*
48. Knot *Calidris canutus*
49. Sanderling, *Calidris alba*
50. Dunlin, *Calidris alpine*
51. Jack snipe, *Lymnocryptes minimus*
52. Snipe, *Gallinago gallinago*
53. Woodcock, *Scolopax rusticola*
54. Black-tailed godwit, *Limosa limosa*
55. Whimbrel, *Numenius phaeopus*
56. Curlew, *Numenius arquata*
57. Redshank*, Tringa tetanus*
58. Greenshank, *Tringa nebularia*

59. Green sandpiper, *Tringa ochropus*
60. Wood sandpiper, *Tringa glareola*
61. Common sandpiper, *Actitis hypoleucos*
62. Turnstone, *Arenaria interpres*
63. Arctic skua, *Stercorarius parasiticus*
64. Long-tailed skua, *Stercorarius longicaudus*
65. Great skua, *Stercorarius skua*
66. Black-headed gull, *Chroicocephalus ridibundus*
67. Common gull, *Larus canus*
68. Lesser black-backed gull, *Larus fuscus*
69. Herring gull, *Larus argentatus*
70. Great black-backed gull, *Larus marinus*
71. Kittiwake, *Rissa tridactyla*
72. Sandwich tern, *Sterna sandvicensis*
73. Arctic tern, *Sterna paradisaea*
74. Common tern, *Sterna hirundo*
75. Guillemot, *Uria aalge*
76. Razorbill, *Alca torda*
77. Black guillemot, *Cepphus grille*
78. Puffin, *Fratercula arctica*
79. Rock dove, *Columba livia*
80. Woodpigeon, *Columba palumbus*
81. Collared dove, *Streptopelia decaocto*
82. Long-eared owl, *Asio otus*
83. Short-eared owl, *Asio flammeus*
84. Skylark, *Alauda arvensis*
85. Shore lark, *Eremophila alpestris*
86. Sand martin, *Riparia riparia*
87. Swallow, *Hirundo rustica*
88. House martin, *Delichon urbicum*
89. Meadow pipit, *Anthus pratensis*
90. Rock pipit, *Anthus petrosus*
91. Grey wagtail, *Motacilla cinerea*
92. Pied/white wagtail, *Motacilla alba*
93. Robin, *Erithacus rubecula*
94. Wren, *Troglodytes troglodytes*
95. Dunnock, *Prunella modularis*
96. Bluethroat, *Luscinia svecica*
97. Black redstart, *Phoenicurus ochruros*
98. Redstart, *Phoenicurus phoenicurus*
99. Whinchat, *Saxicola rubetra*
100. Stonechat, *Saxicola torquatus*
101. Wheatear, *Oenanthe Oenanthe*
102. Ring ouzel, *Turdus torquatus*
103. Blackbird, *Turdus merula*
104. Fieldfare, *Turdis pilaris*
105. Song thrush, *Turdus philomelos*
106. Redwing, *Turdus iliacus*
107. Sedge warbler, *Acrocephalus schoenobaenus*
108. Marsh warbler, *Acrocephalus palustris*
109. Icterine warbler, *Hippolais icterina*

Appendix 5.1b SaxaVord Spaceport Breeding Bird Survey 2022 (Non Confidential)

SaxaVord UK Spaceport Breeding Bird Survey 2022

Alba Ecology Ltd.

Non-confidential version

October 2022

This report should be quoted as '*Alba Ecology Ltd. SaxaVord UK Spaceport Breeding Birds Survey 2022*'.

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INTRODUCTION & METHODS

Following planning approval for a satellite launch facility on Unst, Shetland - known as the SaxaVord UK Space Port (previously known as the 'Shetland Space Centre'), breeding bird surveys (BBS) were conducted in 2022. The BBS surveys included a terrestrial walkover BBS and boat-based seabird counts. This BBS work was undertaken to inform planned pre-construction and construction work and also update the ornithological baseline ahead of launches commencing in 2023.

The Study Area for walkover BBS comprised of the Application Boundary, plus fields to the north of the entrance in an area known as Swartling (Figure 1). Boat-based seabird counts of coastal seabird cliffs were undertaken over a much larger area between the Ura (east side of the Noup), east and southwards down to The Nev (southeast of Hill of Clibberswick) (Figure 1). Black guillemot surveys were conducted by walking along the coast between Ura and The Nev. Additional searches of potential breeding red-throated diver lochans within 4km of the launch site(s) were also undertaken occasionally throughout spring/summer 2022.

Previously the Study Area for the walkover BBS was surveyed under SNH Schedule 1 licence for breeding birds in 2018, 2019 and 2020 by David Cooper. David Cooper and Brydon Thomason also undertook boat-based seabird counts in 2018 and 2020. Both David Cooper and Brydon Thomason are highly experienced and locally based ornithologists and used the relevant standard BBS methods (previously agreed with SNH/NatureScot) during suitable weather conditions. To reduce observer variability and maintain highly experienced observer coverage, the same ornithological surveyors conducted the BBS in 2022.

The boat-based seabird cliff survey methods used were the same as previously reported in Alba Ecology 2018 and 2020 and followed agreed (with SNH/NatureScot) standardised methods e.g. Gilbert *et al*., 1998, Walsh *et al.,* 1995. Terrestrial walkover BBS were conducted under licence twice weekly across the Application Boundary and Swartling between March 2022 and August 2022 (typically up to eight walkover surveys per month).

This report summaries the results for key breeding birds of conservation interest and identifies relatively predictable breeding sites/areas which may make them potentially suitable in terms of setting up monitoring cameras for satellite launches in the future.

RESULTS

The following non-target bird species were recorded breeding within the Study Area in 2022: blackbird, starling, skylark, meadow pipit, rock pipit, pied wagtail, wren, wheatear, snipe and greylag goose.

Black guillemot

The surveys were conducted from first light until particular defined cliff reaches were surveyed, during suitable, calm and clear weather conditions (as per Gilbert *et al*., 1998).

- First black guillemot survey: 27-29th April 2022 = 93 adults.
- Second black guillemot survey: 5-8th May 2022 = 91 adults.

Table 1 summarises the maximum number of adult black guillemots seen on cliffs in 2018, 2020 and 2022 between the coast/cliffs from Ura, east and southwards down to The Nev.

Table 1. Maximum number of black guillemots, Ura to The Nev, Unst, 2018, 2020 and 2022.

Species	2018	2020	2022
Back guillemot maximum count	84 adults	101 adults	93 adults

Black guillemots are mostly hole/crevice nesters and so nest sites are invariably hidden and underground. As a consequence, they are probably a low priority for direct nest monitoring during satellite launches because nests underground will experience much lower noise levels during satellite launches than open, above ground nests. Nevertheless, nest monitoring cameras could be placed into relatively predictable, underground nests.

Cliff nesting seabirds

The summary results in Table 2 give the number of Apparently Occupied Nests (AON) recorded from three boat-based counts undertaken on 19th, 26th June 2022 and 1st July 2022. These boat-based surveys covered the coast/cliffs from Ura, east and southwards down to The Nev. This is the same area previously surveyed by the same surveyors from a boat in 2018 and 2020.

Table 2. Boat-based seabird cliff counts, Ura to The Nev, Unst, June 2022

Species	AON 19/06/22	AON 26/06/22	AON 01/07/22
Shag	28	29	32
Fulmar	3,416	3,150	3,393
Kittiwake	115	118	123
Great black-backed gull	11	8	14
Herring gull	15	19	17
Common guillemot*	96	102	80
Razorbill*	15	20	10
Puffin*	44	115	86

*Total number of individual adults on land in the colony recorded – not AON.

Table 3 summarises the maximum number of AON or adults on land recorded in 2018, 2020 and 2022 between the coast/coastal cliffs from Ura, east and southwards down to The Nev.

Table 3. Maximum boat-based seabird cliff counts, Ura to The Nev, Unst, 2018, 2020 and 2022.

Species	2018 max AON	2020 max AON	2022 max AON
Shag	55 nests	26 nests	32 nests
Fulmar	4,330 AON	2,657 AON	3,416 AON
Kittiwake	55 nests	0 nests	123 nests
Great black-backed gull	2 nests	6 nests	14 nests
Herring gull	0 nests	5 nests	19 nests
Common guillemot*	80 birds	20 birds	102 birds
Razorbill*	11 birds	4 birds	20 birds
Puffin*	49 birds	41 birds	115 birds

*Maximum number of individual adults on land in the colony recorded – not AON.

Comparison from three years' survey work of boat-based surveys covering the coast/cliffs from Ura, east and southwards down to The Nev show substantial annual changes in terms of the maximum Apparently Occupied Nests and/or adults on land recorded in 2018, 2020 and 2022 (Table 3).

Of the eight cliff nesting seabird species recorded, none had their worst breeding year in 2022. Shag numbers slightly improved on the 2020 low of 26 pairs to reach 32 pairs in 2022. Fulmar numbers rebounded after the 2020 low of 2,657 to reach 3,416 AON in 2022 but were not up to the 4,330 AON recorded in 2018. The three cliff-nesting gulls all had their best year to date, with great-black-backed gull improving year on year to each a high of 14 nests in 2022, herring gull reached 19 nests in 2022 and kittiwake rebounded from a complete blank year in 2020 to reach a high of 123 nests in 2022. The three cliff nesting auks all had their best year to date in 2022, with guillemot reaching 102 adults, razorbill with 20 adults and puffin with 115 adults.

Seven of the eight open cliff-nesting species breed in locations that are regularly used and so relatively predictable in terms of potentially setting up nest monitoring cameras for satellite launches. Puffins, like black guillemots, are hole nesters and so nest sites are hidden and underground. As a consequence, they are probably a low priority for monitoring cameras during satellite launches. Nevertheless, cameras could be placed into relatively predictable, underground burrows likely to be used in successive years. With several seabird cliffs used out to 4km from the launch pads (and indeed beyond into the Hermaness, Saxa Vord and Valla Field SPA), there are multiple regularly used locations potentially suitable for monitoring cameras during satellite launches. It should be noted that monitoring seabird colonies on cliffs may require skilled and professionally qualified rope operators; something not considered necessary for other species' monitoring.

Ringed plover

The results of BBS walkovers for ringed plover are summarised in Table 4. It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage ringed plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 4. Estimated number of pairs of ringed plover within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	1 pair Lamba Ness headland	3 pairs Lamba Ness headland	3 pairs, 2 same as May, other failed & new/relay	2 pairs seen, one of other with fledged chicks	0
Confirmed nest/young	0	1 nest (4 eggs), 2 pairs distraction display	1 pair with chicks, 2nd pair distraction	1 pair with chicks, presumed different to June	0

Based on BBS walkover data collected between April and August 2022, there was evidence of 3 pairs of ringed plovers breeding, with 2 presumed different pairs fledging young successfully. All confirmed breeding ringed plovers in 2022 were east of the Garths, out towards the Lamba Ness headland. These nesting locations are very close to the launch pads and would likely be a high priority for early nest camera monitoring.

Oystercatcher

The results of BBS walkovers for oystercatcher are summarised below (Table 5). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage oystercatcher can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 5. Estimated number of pairs of oystercatcher within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	8 pairs across Study Area	9 pairs across Study Area	14 pairs across Study Area	13 pairs across Study Area	8 pairs in 1st week of August, down to 4 pairs by the 2nd week
Confirmed nest/young	0	2 pairs incubating & 3 pairs distraction display	12 pairs incubating, alarming & distraction display	10 pairs alarming & distraction display, 4 pairs with chicks	4 pairs alarming

Based on BBS walkover data collected between April and August 2022, there was evidence of up to 12 pairs of oystercatcher breeding. Breeding oystercatchers were spread across the whole Study Area from Swartling east to the Lamba Ness headland. Oystercatcher nests are relatively easy to locate and being spread throughout the Study Area, nest camera monitoring of this species could take place at different distances from the satellite launches (i.e. nests are not all clumped together), making them a high priority for early nest camera monitoring.

Golden plover

The results of BBS walkovers for golden plover are summarised below (Table 6). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage golden plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 6. Estimated number of pairs of golden plover within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	3 pairs present & displaying on 26/04/22	0	1 pair in Swartling early June, then disappeared	1 pair in Swartling mid July, then disappeared	0
Confirmed nest/young	0	0	0	0	0

Based on BBS data collected between April and August 2022, there was intermittent evidence of a pair present at Swartling in June and July, but no evidence of any successful breeding. With only an apparently single pair, intermittently present, this species is probably a low priority for nest camera monitoring during satellite launches.

Eider

A female eider was found with a nest at Inner Skaw (@ HP 658 155). It fledged successfully. This is the first time this species has been recorded breeding successfully in the Study Area since monitoring began. With only a single breeding attempt, this species is considered a low priority for nest camera monitoring during satellite launches.

Curlew

The results of BBS walkovers for curlew are summarised below (Table 7). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage curlew can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 7. Estimated number of pairs of curlew within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	5 pairs on 07/04/22, later 4 pairs on 25/04/22	4-5 pairs across Study Area	2 pairs	4 pairs	3-4 pairs still alarming
Confirmed nest/young	0	0	0	2 pairs with chicks, other 2 pairs alarming	2 pairs with chicks

Based on BBS walkover data collected between April and August 2022, there was evidence of 4-5 pairs of curlews breeding, with a minimum of 2 presumed different pairs fledging young successfully (possibly more). Confirmed breeding curlews in 2022 were present north and south of Swartling, and between Inner Skaw and the middle of the Study Area. With multiple pairs spread throughout the Study Area, nest camera monitoring of this species could take place at different distances from the satellite launches (i.e. nests are not all clumped together), making them a high priority for early nest camera monitoring.

Redshank

The results of BBS walkovers for redshank are summarised below (Table 8). It is important to recognise that pairs displaying do not necessarily translate to breeding attempts within the Study Area. Passage redshank can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 8. Estimated number of pairs of redshank within the Study Area in 2022.

Study Area	April 2022	May 2022	June 2022	July 2022	August 2022
Max no' pairs displaying	3 pairs, inc 1 copulating at Swartling	1 pair Swartling	1 pair, mid Study Area	1 pair & 2 chicks, mid-east Study Area	0
Confirmed nest/young	0	0	0	1	0

Based on BBS walkover data collected between April and August 2022, there was evidence of 1 pair of redshank breeding successfully at Swartling. Later in the year, adults (which had disappeared from Swartling) were recorded with chicks towards the mid-east of the Study Area and were presumed to be the Swarling pair moving with their precocial chicks. By mid-late July the chicks were considered to have fledged successfully. With only one breeding attempt in 2022, this species is probably a low priority for nest camera monitoring during satellite launches.

Dunlin

One pair displayed in June at Swartling and were not seen again. There was no evidence for breeding in the Study Area in 2022. With no evidence of any successful breeding in 2022, this species is probably a low priority for nest camera monitoring during satellite launches.

Arctic skua

One pair held territory on the slope just west of the Site entrance. In late July the pair were seen with one juvenile, which had fledged by mid-August. With only one breeding attempt in 2022, this species is probably a low priority for nest camera monitoring during satellite launches. Nevertheless, Arctic skua has attempted to bred within the Study Area previously during monitoring and so it is possible that more pairs may occur in the future and so potential nest monitoring should not be wholly discounted.

Birdflu casualties

In common with many parts of Shetland and Unst, surveys in 2022 recorded several dead species which were presumed to have died from birdflu (H5N1 is the strain of avian flu in Scotland). The photographs below of dead great skua and gannet, presumed birdflu casualties, were taken within the Study Area in 2022. According to the RSPB, the virus has killed tens of thousands of seabirds, including many in key Shetland colonies of gannets and great skuas in 2022 (How together we can protect wild birds from Avian Flu | The RSPB).

DISCUSSION

There is direct evidence in 2022 from the Study Area of potentially sensitive and specially protected target bird species breeding within, and adjacent to, the consented planning Application Boundary. The presence of these species should inform the planned monitoring of breeding birds during satellite launches.

Without exception, cliff-nesting seabirds in 2022 had a relatively good breeding season and this has been attributed to reduced predation pressure from great skuas which were particularly adversely affected by avian bird flu, although this was not specifically investigated in this study. Species such as kittiwake have recovered from zero breeding in 2020 to 123 pairs in 2022.

With a good understanding of the up-to-date ornithological baseline, monitoring plans can be developed for a range of species. Following the NatureScot consultation response dated 11 March 2021, Saxa Vord Spaceport made a commitment to a no-launch window whereby no satellite launches, or static tests will be carried out between mid-May and the end of June (subject to ongoing monitoring and appraisal).

Table 10 illustrates the typical breeding calendar of potentially sensitive and protected target Study Area bird species.

Table 10. Typical Breeding Calendar of Potentially Important Study Area Species.

Species	April		May		June		July		August		Reference
Black guillemot											Incubation 23-40 days; Fledging 40 days[1,2,3]
Common guillemot											Incubation 34 days; Fledging 20 days[1,2,3]
Puffin											Incubation 42 days; Fledging 50 days[1,2,3]
Razorbill											Incubation 34 days; Fledging 20 days[1,2,3]
Shag											Incubation 31 days; Fledging 53 days[1,2,3]
Kittiwake											Incubation 29 days; Fledging 43 days[1,2,3]
Herring gull											Incubation 28-30 days; fledging 35-40 days[1,2,3]
Great-black-backed gull											Incubation 27-28 days; fledging 49-56 days[1,2,3]
Fulmar											Incubation 51 days; Fledging 49 days[3]
Ringed plover											Incubation 24 days; Fledging 24 days[1,2,3]
Golden plover											Incubation 29 days; Fledging 30 days[1,2,3]
Dunlin											Incubation 22 days; Fledging 20 days[1,2,3]
Curlew											Incubation 28 days; Fledging 34 days[1,2,3]
Oystercatcher											Incubation 24-27 days; Fledging 30 days[1,2,3]
Redshank											Incubation 22-24 days; Fledging 30-35 days[1,2,3]
Arctic skua											Incubation 27 days; Fledging 28 days[1,2,3]

Red = typical main egg laying/incubation period, Yellow = typical main period dependent young present. Note, table does not include relay or 2nd brood dates. 1 = Gilbert *et al.,* 1998 (reprinted 2011); 2 = Forrester and Andrews (eds), 2007; 3 = Snow and Perrins (eds), 1998.

The six week no-launch window means that the following potentially sensitive and protected target Study Area species may be egg-laying/incubating prior to mid May:

- Common guillemot – potential 4 week window, mid April-mid May.
- Puffin – potential 6 week window, early April- mid May.
- Razorbill – potential 4 week window, mid April-mid May.
- Shag - potential 6 week window, early April- mid May.
- Herring gull – potential 4 week window, mid April-mid May.
- Great-black-backed gull - potential 2 week window, early-mid May.
- Fulmar - potential 2 week window, early-mid May.
- Ringed plover - potential 6 week window, early April- mid May.
- Golden plover - potential 6 week window, early April- mid May.
- Dunlin - potential 4 week window, mid April-mid May.
- Curlew - potential 4 week window, mid April-mid May.
- Oystercatcher – potential 4 week window, mid April-mid May.
- Redshank - potential 6 week window, early April- mid May.

Given the main egg-laying/incubating period prior to mid May and the 2022 BBS results, the following regularly occurring potentially sensitive and protected species are identified for nest monitoring if satellite launches are scheduled in the runup to the six week no-launch window:

1. Common guillemot.
2. Razorbill.
3. Shag.
4. Herring gull.
5. Great-backed gull.
6. Fulmar.
7. Ringed plover.
8. Curlew.
9. Oystercatcher.

Should redshank, golden plover, dunlin and confidential Schedule 1 species breeding numbers increase, then these would also be candidate species for direct nest camera monitoring.

Recent developments in mobile thermal imaging equipment have dramatically increased the success of ornithologists finding the nests of ground nesting birds. A high-quality thermal imager, such as the Pulsar Helion xp28 (or equivalent), is considered by some UK wader researchers to be '*a complete game-changer*' in rapidly locating ground-nesting wader nests as even the eggs 'glow' warm (*Dave Cooper pers comm*). Use of such a thermal imager would potentially save a lot of time in locating suitable wader nests for the cameras to monitor, specifically ringed plover, curlew, oystercatcher and potentially redshank, golden plover, and dunlin.

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Appendix 5.1c SaxaVord Spaceport Breeding Bird Survey 2023 (Non Confidential)

SaxaVord UK Spaceport Breeding Bird Survey 2023

Alba Ecology Ltd.

Ringed plover chick © Dave Cooper

September 2023

This report should be quoted as '*Alba Ecology Ltd. SaxaVord UK Spaceport Breeding Birds Survey 2023*'.

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INTRODUCTION & METHODS

Following planning approval for a satellite launch facility on Unst, Shetland - known as the SaxaVord UK Space Port (previously known as the 'Shetland Space Centre'), breeding bird surveys (BBS) were conducted in 2023. The BBS surveys included a terrestrial walkover BBS and boat-based seabird counts. This BBS work was undertaken to inform planned construction work and also update the ornithological baseline ahead of planned satellite launches commencing in 2024.

The Study Area for walkover BBS comprised of the Application Boundary, plus fields to the north of the entrance in an area known as Swartling. Boat-based seabird counts of coastal seabird cliffs were undertaken over a much larger area (out to c. 4km from planned launch pads) between the Ura (east side of the Noup), east and southwards down to The Nev (southeast of Hill of Clibberswick) (Figure 1). Black guillemot surveys were conducted by walking along the coast between Ura and The Nev.

Previously the Study Area for the walkover BBS was surveyed under SNH Schedule 1 licence for breeding birds in 2018, 2019, 2020 and 2022 by David Cooper. David Cooper and Brydon Thomason also undertook boat-based seabird counts in 2018, 2020 and 2022. Both David Cooper and Brydon Thomason are highly experienced and locally based ornithologists and used the relevant standard BBS methods (previously agreed with SNH/NatureScot) during suitable weather conditions. To reduce observer variability and maintain highly experienced observer coverage, the same ornithological surveyors conducted the BBS in all previous years. During 2023 BBS walkovers David Cooper was often accompanied by Callum Ward, the site Ecological Clerk of Works.

The boat-based seabird cliff survey methods used were the same as previously reported in Alba Ecology 2018, 2020 and 2022 and followed agreed (with SNH/NatureScot) standardised methods e.g. Gilbert *et al*., 1998, Walsh *et al.,* 1995. Terrestrial walkover BBS were conducted under licence approximately twice weekly across the Application Boundary and Swartling between March 2023 and August 2023 (typically up to eight walkover surveys per month, expect August when they ceased mid-month) as per 2022 BBS walkovers.

This report summaries the results for key breeding birds of conservation interest and identifies relatively predictable breeding sites/areas which may make them potentially suitable in terms of setting up monitoring cameras for satellite launches in the future.

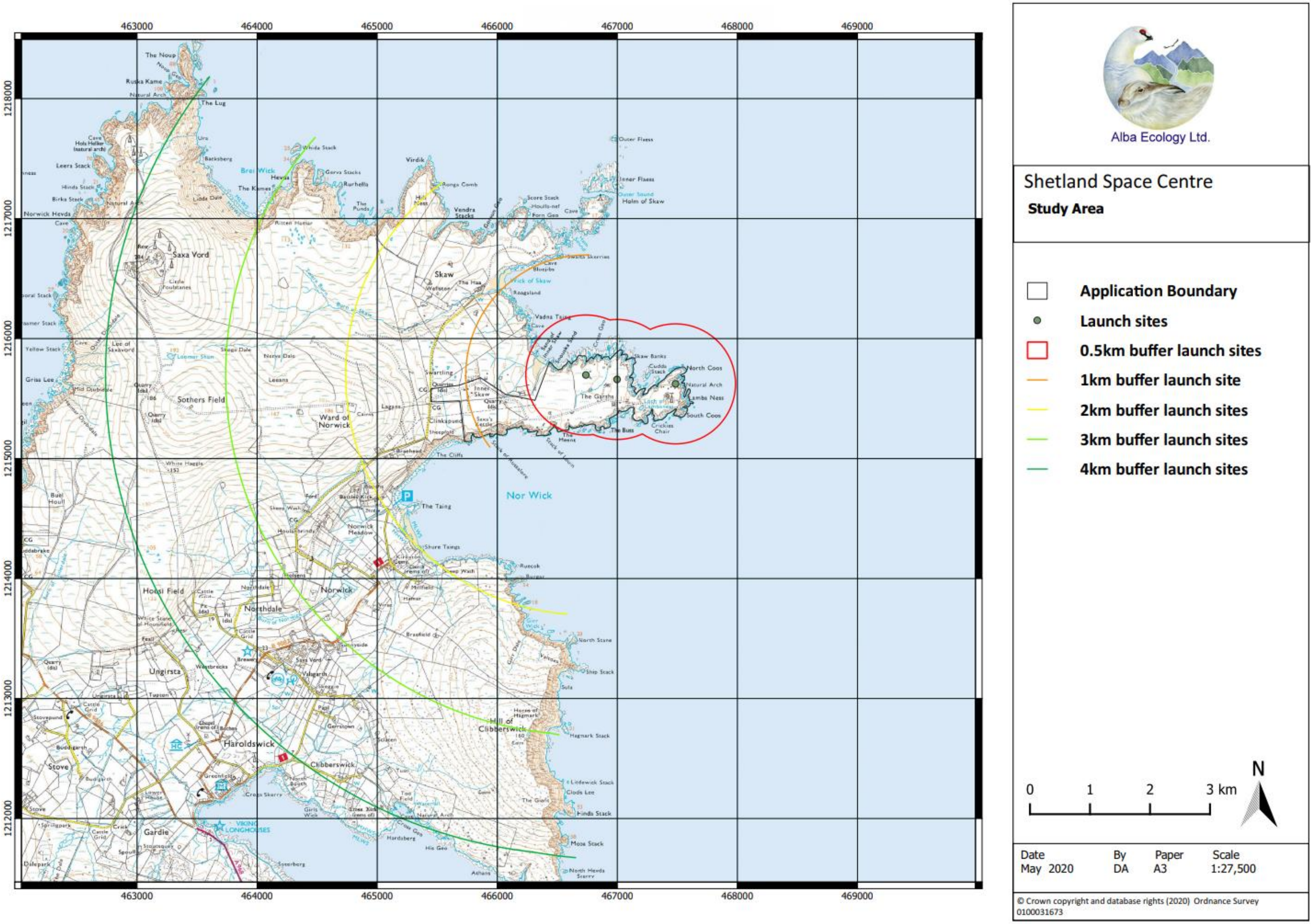

Figure 1. BBS Study Area.

RESULTS

The following non-target bird species were recorded breeding within the Study Area in 2023: eider, greylag goose, hooded crow, raven, blackbird, starling, skylark, meadow pipit, rock pipit, pied wagtail, wren, wheatear and possibly twite (unconfirmed).

Black guillemot

The surveys were conducted from first light until particular defined cliff reaches were surveyed, during suitable, calm and clear weather conditions (as per Gilbert *et al*., 1998).

- First black guillemot survey: 2-4th April 2023 = 87 adults.
- Second black guillemot survey: 9-15th May 2023 = 107 adults.

Table 1 summarises the maximum number of adult black guillemots seen on cliffs in 2018, 2020, 2022 and 2023 between the coast from Ura, east and southwards down to The Nev.

Table 1. Maximum number of black guillemots, Ura to The Nev, Unst, 2018, 2020, 2022 and 2023.

Species	2018	2020	2022	2023
Back guillemot maximum count	84 adults	101 adults	93 adults	107 adults

Black guillemots are mostly hole/crevice nesters and so nest sites are invariably hidden and underground. As a consequence, they are probably a low priority for direct nest monitoring during satellite launches because nests underground will experience much lower noise levels during satellite launches than open, above ground nests. Nevertheless, nest monitoring cameras could be placed into relatively predictable, underground nests.

Cliff nesting seabirds

The summary results in Table 2 give the number of Apparently Occupied Nests (AON) recorded from three boat-based counts undertaken on 7th, 18th and 27th June 2023. These boat-based surveys covered the coast/cliffs from Ura, east and southwards down to The Nev. This is the same area previously surveyed by the same surveyors from a boat in 2018, 2020, 2022 and 2023.

Table 2. Boat-based seabird cliff counts, Ura to The Nev, Unst, June 2023

Species	AON 07/06/23	AON 18/06/23	AON 27/06/23
Shag	30	45	42
Fulmar	2,771	3,212	3,188
Kittiwake	102	109	114
Great black-backed gull	2	11	10
Lesser black backed gull	0	3	3
Herring gull	4	16	20
Common guillemot*	73	178	187
Razorbill*	23	24	19
Puffin*	1	106	150

*Total number of individual adults on land in the colony recorded – not AON.

Table 3 summarises the maximum number of AON/adults on land recorded in 2018, 2020, 2022 and 2023 between the coast/coastal cliffs from Ura, east and southwards to The Nev.

Table 3. Maximum boat-based seabird cliff counts, Ura to The Nev, Unst, 2018, 2020, 2022 and 2023.

Species	2018 max AON	2020 max AON	2022 max AON	2023 max AON
Shag	55 nests	26 nests	32 nests	42 nests
Fulmar	4,330 AON	2,657 AON	3,416 AON	3,188 AON
Kittiwake	55 nests	0 nests	123 nests	114 nests
Great black-backed gull	2 nests	6 nests	14 nests	10 nests
Lesser black-backed gull	0 nests	0 nests	0 nests	3 nests
Herring gull	0 nests	5 nests	19 nests	20 nests
Common guillemot*	80 birds	20 birds	102 birds	187 nests
Razorbill*	11 birds	4 birds	20 birds	24 birds
Puffin*	49 birds	41 birds	115 birds	150 birds

*Maximum number of individual adults on land in the colony recorded – not AON.

Comparison from four years' survey work of boat-based surveys covering the coast/cliffs from Ura, east and southwards down to The Nev show substantial annual changes in terms of the maximum Apparently Occupied Nests and/or adults on land recorded in 2018, 2020, 2022 and 2023 (Table 3).

Of the eight cliff nesting seabird species recorded, none had their worst breeding years in 2022-2023, when construction activity was at its peak. Shag numbers have improved on the 2020 low of 26 pairs to reach 42 pairs in 2023. Fulmar numbers rebounded after the 2020 low of 2,657 to reach 3,416 AON in 2022 and 3,188 AON in 2023 but were not up to the 4,330 AON recorded in 2018. The four cliff-nesting gulls all had their best year to date during the peak construction period 2022-2023. The three cliff nesting auks all had their best years to date in 2022 and 2023, with guillemot reaching 187 adults, razorbill with 24 adults and puffin with 150 adults in 2023.

Seven of the eight open cliff-nesting species breed in locations that are regularly used and so relatively predictable in terms of potentially setting up nest monitoring cameras for satellite launches. Puffins, like black guillemots, are hole nesters and so nest sites are hidden and underground. As a consequence, they are probably a low priority for monitoring cameras during satellite launches. Nevertheless, cameras could be placed into relatively predictable, underground burrows likely to be used in successive years. With several seabird cliffs used out to 4km from the launch pads (and indeed beyond into the Hermaness, Saxa Vord and Valla Field SPA), there are multiple regularly used locations potentially suitable for monitoring cameras during satellite launches. It should be noted that monitoring nests in seabird colonies on cliffs will require a skilled and professionally qualified rope operator; something not considered necessary for other species' monitoring.

Tempting as it may be to infer that construction activity has helped breeding seabirds, a much more likely explanation is that the increase in seabird numbers across the board is likely to reflect a combination of suitable foraging (food was available) and a substantial reduction in predation because of the collapse in the bonxie (great skua) population due to birdflu. Regardless, these data provide a robust evidential basis on which to assess potential future launch impacts on seabirds, and they show no adverse population impact on breeding seabirds during the main 2022-2023 construction period.

Ringed plover

The results of BBS walkovers for ringed plover are summarised in Table 4. It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage ringed plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 4. Estimated number of pairs of ringed plover within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	3	3	5-6	7	2
Confirmed nest/young	0	2	3	7	2

In 2023 a maximum of seven ringed plover pairs held territory and had nests, most of which were successfully hatched based on distraction display of the adult and sightings of juveniles.

Oystercatcher

The results of BBS walkovers for oystercatcher are summarised below (Table 5). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage oystercatcher can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 5. Estimated number of pairs of oystercatcher within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	3-4	9	16	17	3
Confirmed nest/young	0	1	1	Many	0

In 2023 a maximum of seventeen oystercatcher pairs potentially held territory and had nests, several of which had juveniles, which quickly dispersed around the Study Area making a determination of successful breeding attempts somewhat challenging given that they were numerous. Additionally, there were often 'noisy' groups of non-breeders that regularly exhibited breeding behaviour confusing matters further. Consequently the term 'many' is used in Table 5, rather than provision of what is likely to be a spurious metric. There has been a notable increase in oystercatchers breeding with likely reductions in bonxie predation and a lot more suitable breeding areas created now with wide 'track-sides', top of the various bunds, large 'landscaped' areas, areas where topsoil was removed >12 months ago but left undeveloped since.

Golden plover

The results of BBS walkovers for golden plover are summarised below (Table 6). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage golden plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 6. Estimated number of pairs of golden plover within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	2-3	1	1	1	0
Confirmed nest/young	0	0	0	0	0

In 2023 a maximum of one golden plover pair held territory and no nests or juveniles were recorded. Therefore, there was no evidence of a successful breeding attempt.

Curlew

The results of BBS walkovers for curlew are summarised below (Table 7). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage curlew can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 7. Estimated number of pairs of curlew within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	5-6	7-9	8	8-9	4
Confirmed nest/young	0	2	2	8-9	4

In 2023 a maximum of eight-nine curlew pairs held territory and had nests, most of which were successfully hatched based on distraction display of the adult and sightings of juveniles.

Redshank

The results of BBS walkovers for redshank are summarised below (Table 8). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage redshank can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 8. Estimated number of pairs of redshank within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	2	1	1	1	0
Confirmed nest/young	0	0	1	1	0

In 2023 a maximum of one redshank pair held territory and one nest with four fledged juveniles was recorded.

Lapwing

The results of BBS walkovers for lapwing are summarised below (Table 9). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the

Study Area. Passage lapwing can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 9. Estimated number of pairs of lapwing within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	1	2	1	2	0
Confirmed nest/young	0	0	0	0	0

In 2023 up to two lapwing pairs held territory and in July up to four adults were seen together. No nests or juveniles were recorded, so therefore there was no evidence of a successful breeding attempt.

Snipe

The results of BBS walkovers for snipe are summarised below (Table 10). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. This is a notoriously difficult breeding bird to survey accurately and so caution should be exercised when comparing numbers between months and years. Passage snipe can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 10. Estimated number of pairs of snipe within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	2/3	1	3	4	1
Confirmed nest/young	0	0	0	2	0

In 2023 three-four snipe pairs held territory and juveniles were recorded in two widely separated areas suggestive of at least two successful breeding attempts.

Dunlin

The results of BBS walkovers for dunlin are summarised below (Table 11). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage dunlin can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 11. Estimated number of pairs of dunlin within the Study Area in 2023.

Study Area	April 2023	May 2023	June 2023	July 2023	August 2023
Max no' pairs displaying	0	2	1	0	0
Confirmed nest/young	0	0	0	0	0

In 2023 up to two dunlin pairs held territory. No nests or juveniles were recorded in the key part of the breeding season, although juveniles were seen later on they could have come from anywhere on Unst. Therefore, there was no direct evidence of a successful breeding attempt.

Whimbrel

One display flight in June 2023 but the birds disappeared prior to commencing breeding activity. This was the only sign of breeding behaviour in 2023. Therefore, there was no evidence of a successful breeding attempt in 2023.

Arctic skua

One pair was present and in held territory in May and June. No nest or juveniles were recorded, so therefore there was no evidence of a successful breeding attempt in 2023.

DISCUSSION

There is direct evidence in 2023 from the Study Area of potentially sensitive and specially protected target bird species breeding within, and adjacent to, the consented planning Application Boundary. The presence of these species should inform the planned monitoring of breeding birds during satellite launches.

With a good understanding of the up-to-date ornithological baseline, monitoring plans can be developed for a range of species. Following the NatureScot consultation response dated 11 March 2021, Saxa Vord Spaceport made a commitment to a no-launch window whereby no satellite launches, or static tests will be carried out between mid-May and the end of June (subject to ongoing monitoring and appraisal).

Table 12 illustrates the typical breeding calendar of potentially sensitive and protected target Study Area bird species.

Table 12. Typical Breeding Calendar of Potentially Important Study Area Species.

Species	April		May		June		July		August		Reference
Black guillemot											Incubation 23-40 days; Fledging 40 days[1,2,3]
Common guillemot											Incubation 34 days; Fledging 20 days[1,2,3]
Puffin											Incubation 42 days; Fledging 50 days[1,2,3]
Razorbill											Incubation 34 days; Fledging 20 days[1,2,3]
Shag											Incubation 31 days; Fledging 53 days[1,2,3]
Kittiwake											Incubation 29 days; Fledging 43 days[1,2,3]
Herring gull											Incubation 28-30 days; fledging 35-40 days[1,2,3]
Great-black-backed gull											Incubation 27-28 days; fledging 49-56 days[1,2,3]
Fulmar											Incubation 51 days; Fledging 49 days[3]
Ringed plover											Incubation 24 days; Fledging 24 days[1,2,3]
Golden plover											Incubation 29 days; Fledging 30 days[1,2,3]
Dunlin											Incubation 22 days; fledging 20 days[1,2,3]

Curlew											Incubation 28 days; Fledging 34 days[1,2,3]
Oystercatcher											Incubation 24-27 days; Fledging 30 days[1,2,3]
Redshank											Incubation 22-24 days; Fledging 30-35 days[1,2,3]
Arctic skua											Incubation 27 days; Fledging 28 days[1,2,3]

Red = typical main egg laying/incubation period, Yellow = typical main period dependent young present. Note, table does not include relay or 2nd brood dates. 1 = Gilbert *et al.,* 1998 (reprinted 2011); 2 = Forrester and Andrews (eds), 2007; 3 = Snow and Perrins (eds), 1998.

The six week no-launch window means that the following potentially sensitive and protected target Study Area species may be egg-laying/incubating prior to mid May:

- Common guillemot – potential 4 week window, mid April-mid May.
- Puffin – potential 6 week window, early April- mid May.
- Razorbill – potential 4 week window, mid April-mid May.
- Shag - potential 6 week window, early April- mid May.
- Herring gull – potential 4 week window, mid April-mid May.
- Great-black-backed gull - potential 2 week window, early-mid May.
- Fulmar - potential 2 week window, early-mid May.
- Ringed plover - potential 6 week window, early April- mid May.
- Golden plover - potential 6 week window, early April- mid May.
- Dunlin - potential 4 week window, mid April-mid May.
- Curlew - potential 4 week window, mid April-mid May.
- Oystercatcher – potential 4 week window, mid April-mid May.
- Redshank - potential 6 week window, early April- mid May.

Given the main egg-laying/incubating period prior to mid May and the 2022-2023 BBS results, the following regularly occurring potentially sensitive and protected (above ground) species are identified for nest monitoring if satellite launches are scheduled in the runup to the six week no-launch window:

1. Common guillemot.
2. Razorbill.
3. Shag.
4. Herring gull.
5. Great-backed gull.
6. Fulmar.
7. Ringed plover.
8. Curlew.
9. Oystercatcher.

Should redshank, golden plover, dunlin and confidential Schedule 1 species breeding numbers increase, then these would also be candidate species for direct nest camera monitoring.

Finally, with little sheep grazing activity within the site during construction in 2023, the habitat composition has begun to subtly change, and the taller vegetation in 2023 will likely have benefited some species e.g. curlew but potentially adversely affected others e.g. whimbrel and Arctic skua. Once operational, grazing management will resume, and so species composition may shift slightly in future years.

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Appendix 5.1d SaxaVord Spaceport Breeding Bird Survey 2024 (Non Confidential)

SaxaVord UK Spaceport Breeding Bird Survey 2024

Alba Ecology Ltd.

Non-confidential version

Kittiwake nests © Dave Cooper

September 2024

This report should be quoted as '*Alba Ecology Ltd. SaxaVord UK Spaceport Breeding Birds Survey 2024 – Non-confidential version*'.

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INTRODUCTION & METHODS

Following planning approval for a satellite launch facility on Unst, Shetland - known as the SaxaVord UK Space Port (previously known as the ‘Shetland Space Centre’), breeding bird surveys (BBS) were conducted in 2024. The BBS surveys included a terrestrial walkover BBS and boat-based seabird counts. This BBS work was undertaken, as in previous years, to inform planned construction work and also update the ornithological baseline ahead of planned satellite launches.

The Study Area for walkover BBS comprised of the Application Boundary, plus fields to the north of the entrance in an area known as Swartling. Boat-based seabird counts of coastal seabird cliffs were undertaken over a much larger area (out to c. 4km from planned launch pads) between the Ura (east side of the Noup), east and southwards down to The Nev (southeast of Hill of Clibberswick) (Figure 1). Black guillemot surveys were conducted by walking along the coast between Ura and The Nev.

Previously the Study Area for the walkover BBS was surveyed under SNH Schedule 1 licence for breeding birds in 2018, 2019, 2020, 2022 and 2023 by David Cooper. David Cooper and Brydon Thomason also undertook boat-based seabird counts in 2018, 2020, 2022, 2023 and 2024. Both David Cooper and Brydon Thomason are highly experienced and locally based ornithologists and used the relevant standard BBS methods (previously agreed with SNH/NatureScot) during suitable weather conditions. To reduce observer variability and maintain highly experienced observer coverage, the same ornithological surveyors conducted the BBS in all previous years.

The boat-based seabird cliff survey methods used were the same as previously reported in Alba Ecology 2018, 2020, 2022 and 2023 and followed agreed (with SNH/NatureScot) standardised methods e.g. Gilbert *et al*., 1998, Walsh *et al.,* 1995. Terrestrial walkover BBS were conducted by Dave Cooper under licence approximately twice once weekly across the Application Boundary and Swartling between March April 2024 and August 2024 (typically up to five walkover surveys per month, expect except August when they ceased mid-month) as per 2022-2023 BBS walkovers.

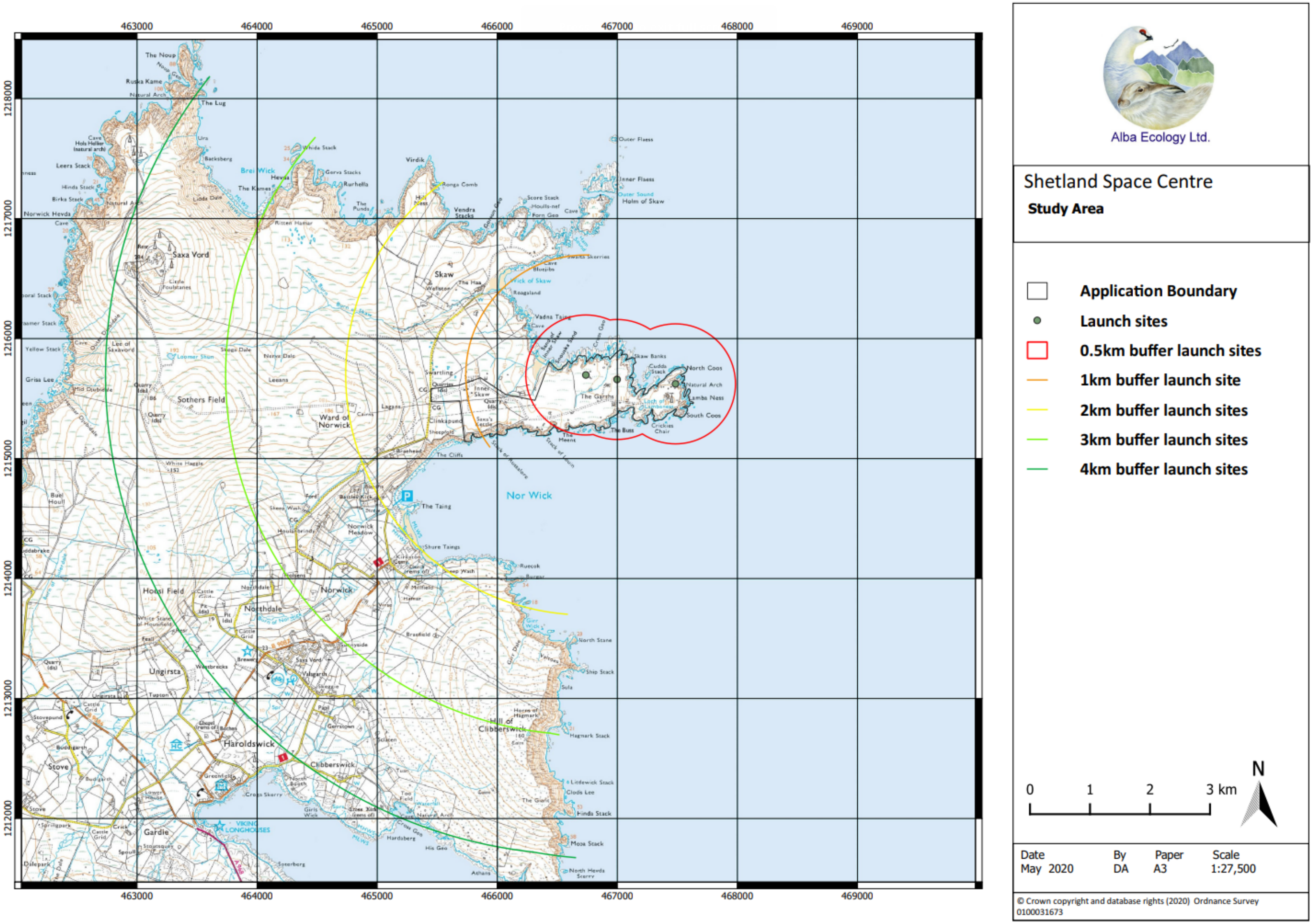

Figure 1. BBS Study Area.

RESULTS

The following non-target bird species were recorded breeding within the Study Area in 2024: eider, greylag goose, hooded crow, raven, blackbird, starling, skylark, meadow pipit, rock pipit, pied wagtail, wren, wheatear and possibly twite (unconfirmed).

Black guillemot

The surveys were conducted from first light until particular defined cliff reaches were surveyed, during suitable, calm and clear weather conditions (as per Gilbert *et al*., 1998).

- Black guillemot survey: April 2024 = 130 adults.
- Black guillemot survey: May 2024 = 102 adults

Black guillemots are mostly hole/crevice nesters and so nest sites are invariably hidden and underground. Table 1 summarises the maximum number of adult black guillemots sat on cliffs or seen sat on the sea below cliffs offering suitable nesting sites in 2018,2020, 2022, 2023 and 2024 between the coast from Ura, east and southwards down to The Nev.

Table 1. Maximum number of black guillemots, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018	2020	2022	2023	2024
Back guillemot maximum count	84 adults	101 adults	93 adults	107 adults	130 adults

Cliff nesting seabirds

The summary results in Table 2 give the number of Apparently Occupied Nests (AON) recorded from three boat-based counts undertaken between 22nd June, 30th June and 8th July 2024. These boat-based surveys covered the coast/cliffs from Ura, east and southwards down to The Nev. This is the same area previously surveyed by the same surveyors from a boat in 2018, 2020, 2022 and 2023.

Table 2. Boat-based seabird cliff counts, Ura to The Nev, Unst, June 2024

Species	AON 22/06/24	AON 30/06/24	AON 08/07/24
Shag	47	43	35
Fulmar	2,711	3,868	2,415
Kittiwake	95	106	110
Great black-backed gull	8	9	9
Lesser black backed gull	0	0	1
Herring gull	1	8	14
Common guillemot*	61	64	68
Razorbill*	5	4	6
Puffin*	151	12	78

*Total number of individual adults on land in the colony recorded – not AON.

Table 3 summarises the maximum number of AON/adults on land recorded in 2018, 2020, 2022, 2023 and 2024 between the coast/coastal cliffs from Ura, east and southwards to The Nev.

Table 3. Maximum boat-based seabird cliff counts, Ura to The Nev, Unst, 2018, 2020, 2022, 2023 and 2024.

Species	2018 max AON	2020 max AON	2022 max AON	2023 max AON	2024 max AON
Shag	55 nests	26 nests	32 nests	42 nests	47 nests
Fulmar	4,330 AON	2,657 AON	3,416 AON	3,188 AON	3,868 AON
Kittiwake	55 nests	0 nests	123 nests	114 nests	110 nests
Great black-backed gull	2 nests	6 nests	14 nests	10 nests	9 nests
Lesser black-backed gull	0 nests	0 nests	0 nests	3 nests	1 nest
Herring gull	0 nests	5 nests	19 nests	20 nests	14 nests
Common guillemot*	80 birds	20 birds	102 birds	187 birds	68 birds
Razorbill*	11 birds	4 birds	20 birds	24 birds	6 birds
Puffin*	49 birds	41 birds	115 birds	150 birds	151 birds

*Maximum number of individual adults on land in the colony recorded – not AON.

Comparison from five years' survey work of boat-based surveys covering the coast/cliffs from Ura, east and southwards down to The Nev show substantial annual changes in terms of the maximum AON and/or adults on land recorded in 2018, 2020, 2022, 2023 and 2024 (Table 3).

Of the eight cliff nesting seabird species recorded, none had their worst breeding years in 2022-2024, when construction activity was at its peak. Shag numbers have improved on the 2020 low of 26 pairs to reach 47 pairs in 2024. Fulmar numbers rebounded after the 2020 low of 2,657 to reach 3,868 AON in 2024 but were not up to the 4,330 AON recorded earlier in 2018. The four cliff-nesting gulls all had their best year to date during the peak construction period 2022-2024. The three cliff nesting auks also had their best years to date between 2022 and 2024. However, in 2024 guillemot numbers (68 birds) were well down on those recorded in 2023 (187 birds). Razorbill numbers were also noticeably down in 2024 with only 6 birds compared to 2023 when 24 birds were present. Puffins appear to be doing well with c. 150 adults in both 2023 and 2024, the highest number during the monitoring period.

Tempting as it may be to infer that construction activity has helped breeding seabirds, a much more likely explanation is that the increase in seabird numbers across the board is likely to reflect a combination of suitable foraging (food was available) and a substantial reduction in predation because of the collapse in the bonxie (great skua) population due to birdflu. Regardless, these data provide a robust evidential basis on (i) a lack of detrimental disturbance impacts on populations during the 2022-2024 construction period, and (ii) a baseline on which to assess potential future launch impacts on seabirds.

Eider

A single nest was recorded on the edge of the materials compound in May 2024. The nest site was fenced from the construction site on the south side to reduce the chances of the nest being inadvertently disturbed/accidentally destroyed. As with all nests, staff working in the area were briefed on the nest location.

Ringed plover

The results of BBS walkovers for ringed plover are summarised in Table 4. It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage ringed plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 4. Estimated number of pairs of ringed plover within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	7 pairs	8 pairs	9 pairs	8 pairs	0

In 2024 a maximum of nine ringed plover pairs held territory (seven in 2023), several of which were successfully hatched based on distraction display of the adult and sightings of juveniles.

Golden plover

The results of BBS walkovers for golden plover are summarised below (Table 5). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage golden plover can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 5. Estimated number of pairs of golden plover within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	1 pair	1 pair	2 pairs	0	0

In 2024 a maximum of two golden plover pairs held territory (one pair in 2023), but only one pair held territory over three months; no nests or juveniles were recorded. Therefore, it is likely that only one breeding attempt was successful.

Oystercatcher

The results of BBS walkovers for oystercatcher are summarised below (Table 6). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the

Study Area. Passage oystercatcher can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 6. Estimated number of pairs of oystercatcher within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	11 pairs	13 pairs	18-20 pairs	20-21 pairs	0

In 2024 a maximum of c. twenty oystercatcher pairs potentially held territory and had nests (seventeen in 2023), several of which had juveniles, which quickly dispersed around the Study Area making a determination of successful breeding attempts somewhat challenging given that they were numerous. Additionally, there were often 'noisy' groups of non-breeders that regularly exhibited breeding behaviour confusing matters further. Therefore, rather than provide what is likely to be a spurious metric, approximately twenty pairs were considered to have bred in the Study Area in 2024. There has been a notable recent increase in oystercatchers breeding with likely reductions in bonxie predation and a lot more suitable breeding areas created now with wide 'track-sides', top of the various bunds, large 'landscaped' areas, areas where topsoil was removed left undeveloped since.

Curlew

The results of BBS walkovers for curlew are summarised below (Table 7). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Curlews can have relatively large and complex territories, making determination of the number of pairs (in an unmarked population) challenging. Passage curlew can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 7. Estimated number of pairs of curlew within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	6-8 pairs	4-5 pairs	6-8 pairs	7 pairs	0

In 2024 a maximum of seven-eight curlew pairs held territory and had nests (eight-nine in 2023), several of which were likely successfully hatched based on distraction display of the adult and sightings of juveniles.

Redshank

The results of BBS walkovers for redshank are summarised below (Table 8). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage redshank can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 8. Estimated number of pairs of redshank within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	3 pairs	2 pairs	3 pairs	2 pairs	0

In 2024 a maximum of three redshank pairs held territory (one pair in 2023).

Lapwing

The results of BBS walkovers for lapwing are summarised below (Table 9). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage lapwing can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 9. Estimated number of pairs of lapwing within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	4 pairs	4 pairs	2 pairs	0	0

In 2024 up to four lapwing pairs held territory in the Study Area (two pairs in 2023).

Snipe

The results of BBS walkovers for snipe are summarised below (Table 10). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Snipe is a notoriously difficult breeding bird to survey accurately, and so care should be exercised when comparing numbers between months and years. Passage snipe can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 10. Estimated number of pairs of snipe within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	4-5 pairs	4-5 pairs	4 pairs	3 pairs	0

In 2024 four-five snipe pairs apparently held territory in the Study Area (three-four pairs in 2023). Given the uncertainties regarding surveying this highly cryptic species, the suggestion of an additional pair was present in 2024 should be treated with caution.

Dunlin

The results of BBS walkovers for dunlin are summarised below (Table 11). It is important to recognise that birds displaying do not necessarily translate to breeding attempts within the Study Area. Passage dunlin can move through an area and some birds display to each other when away from their territories e.g. when foraging.

Table 11. Estimated number of pairs of dunlin within the Study Area in 2024.

Study Area	April 2024	May 2024	June 2024	July 2024	August 2024
Max no' pairs displaying	0	0	2 pairs?	0	0

In 2024 up to two dunlin pairs held territory in June (two pairs in 2023). There were no records of dunlin exhibiting breeding behaviour in May; the only record was of a single bird on the shoreline at Wick of Skaw on 11th May 2024. No nests or juveniles were recorded in the key part of the breeding season, although juveniles were seen later on (as they were in 2023) and they could have come from anywhere on Unst. Therefore, there was no direct evidence of a successful breeding attempt in the Study Area.

Whimbrel

One pair was present and displaying in suitable habitat at the access track/road end in two consecutive survey visits in July 2024. No nest or juveniles were recorded, so therefore there was no evidence of a successful breeding attempt in 2024 (as was also the case in 2023).

Arctic skua

One pair was present and displaying in suitable habitat at the access track/road end in May and June 2024. No nest or juveniles were recorded, so therefore there was no evidence of a successful breeding attempt in 2024 (as was also the case in 2023).

DISCUSSION

As with previous years, there was direct evidence in 2024 from the Study Area of potentially sensitive and specially protected target bird species breeding within, and adjacent to, the consented development boundary. As with 2022-2023, the presence of these species informed construction works throughout the 2024 breeding season.

Of the eight cliff nesting seabird species recorded, none had their worst breeding years in 2022-2024, when construction activity was at its peak. These data provide robust and compelling evidence of a lack of detrimental disturbance impacts on seabird populations during the 2022-2024 construction period. Of the ground nesting landbirds in the Study Area, populations were broadly similar or increased on those recorded in 2023. However, it should be noted that whimbrel and Arctic skua did not breeding in and around the main construction area (where they previously did prior to construction), but both species were recorded exhibiting breeding behaviour in potentially suitable habitat at the track end/join with the public road to the west of the Study Area in 2024.

The breeding birds data collected in 2024 and in previous years provides a robust evidence base against which potential population changes during the operational phase of the development could be assessed.

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Appendix 5.2 Background Literature Review

Appendix 5.2 Background Literature Review of Potential Noise Impacts on Birds for the Shetland Space Centre

Alba Ecology Ltd.

2020

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Background literature review of potential noise impacts on birds for the Shetland Space Centre

Can loud noises from rocket launches kill birds? There is no evidence found from the published literature, with lots of photos demonstrating that the noise from much larger rockets than those proposed at the Shetland Space Centre has not instantly killed the birds in the pictures (note a very small number of birds have been killed during launches due to direct collision with the rocket). Two examples of typical launch photos from on-line are provided below.

There are two components to noise, frequency measured in Hertz (Hz) and loudness measured in decibels (dB). The decibel scale is logarithmic, so the difference between the noise at 90dB is ten times that of 80dB, and 100dB is 100 times louder than 80dB.

The general structure of birds' ears shows little variation between species (Encyclopaedia Britannica, 2020). Birds hearing is sensitive, with birds able to detect shorter and lower sounds than humans. The hearing range of a typical bird is between 100Hz to 8-10kHz, sensitivity at 0-10dB, hearing best between 1-4kHz (Beason, 2004) with some species hearing range extending up to 12kHZ (Cotanche, 2008). For comparison, human hearing range is typically between 20 to 20kHz. Data on hearing range is available for one of the species of interest to the proposed development; puffin (*Fratercula arctica*) which has a hearing range 500Hz to 8kHz (Mooney *et al.* 2019). As rockets launch noise is concentrated in the low to mid frequencies (Lubert, 2017), well within both puffin and a typical birds' hearing range, it is fair to conclude that rocket/satellite launch noise frequencies will be audible to all species potentially impacted by the proposed Shetland Space Centre (SSC) development.

Noise in general has been shown to impact on wildlife populations, reducing biodiversity including birds, causing for example stress and affecting productivity and immune function (Wolfenden, 2017). Additionally, proximity to infrastructure (and perhaps associated noise) has been shown to reduce breeding productivity in some species; for example, red-necked phalarope (*Phalaropus lobatus*) breeding in Alaska (Liebezeit *et al.* 2009). Response to noise will depend on how far away an animal is from the noise source, as noise attenuates (i.e. reduces) over distance (Bowles, 1995).

Much of the literature available on noise has studied the effect of chronic noise on bird populations. Chronic and frequent noise interferes with an organism's ability to detect important sound (Francis & Barber, 2013) and has been demonstrated to reduce reproductive success in for example great tit (*Parus major*), a common woodland species (Halfwerk *et al.* 2011). In addition to a reduction in reproductive success, long term exposure to road traffic noise can cause oxidative stress. In nestling tree swallow (*Tachycineta bicolor*) oxidative stress is associated with ageing and an increased risk of disease, thus both the increased oxidative stress and smaller nestling size from road noise demonstrates the potential for exposure to loud noise to result in long term impacts for an individual which may ultimately be seen at a population level (Injaian *et al.* 2018). Behaviour may be adapted to offset the effects of chronic noise, for example, chiffchaff (*Phylloscopus collybita*) reduce the frequency of their song in response to chronic airport noise (Wolfenden *et al*. 2019) to facilitate communication.

Although the impacts of chronic noise are relatively well studied, chronic noise studies may be of limited relevance in considering the impact of much louder impulsive occasional noise (a short duration noise event that occurs over a range of frequencies) experienced during rocket/satellite launches. Loud noise events are often reacted to as a threat by birds (Francis & Barber, 2013), causing them to alter behaviour in response. As such impulsive events by their nature are infrequent, and so habituation to these events is considered less likely.

Impacts of impulsive noise can be divided into lethal, sub-lethal and trivial/non-existent effects. Lethal effects may occur when a loud noise results in mortality, for example if the startled 'flight' response to a stimulus leads to a collision with a nearby object. Increased noise intensity will increase the severity of the likely response (Francis and Barber, 2013). Dependant young are more likely than adults to suffer lethal effects through exposure, interruption in provision of care or, in extreme cases, being knocked out the nest during a parent's startled/frightened reaction. 'Flight' responses causing startled animals to alter their behaviour including fleeing is similar to, for example, an organism's response to a predation risk event. Most noise startle events will not result in mortality to adults, but instead sub-lethal effects may possibly be observed e.g. by reducing fecundity or increasing stress. Sub-lethal effects of loud noises additionally could involve temporary damage to the birds' hearing structure, however, birds unlike humans are able to regenerate damaged auditory hair cells. Physical trauma to the ear is more commonly the result of impulse noise rather than continuous noise as continuous noise loud enough to cause permanent damage is rarer than similarly loud impulsive noise (Larkin *et al*. 1996). The noise level that causes damage and the extent of damage varies depending on the species of bird (Beason, 2004).

Birds, unlike in humans, are able to regenerate damaged auditory (cochlear) hair cells and so any damage to auditory hair cells is potentially reversible. Hair cells are regenerated following a process called apoptosis, which is programmed cell death in response to inhospitable environments. Cells adjacent to those undergoing apoptosis are able to produce new hair cells within a matter of days through both direct trans-differentiation and mitotic regeneration (Cotanche, 2008) to replace those dying cells. This process of regeneration takes approximately two months to complete depending on the extent of the damage (Bowles, 1995). Given that the proposed schedule of SSC satellite launches are at least monthly throughout the year, were significant damage to occur to a birds' hearing, then insufficient time would likely occur between launches to allow for full repair/recovery between launches.

This literature review aims to look at how impulsive noise (from various sources including aircraft, fireworks, military ranges and rocket launches) impacts on both bird populations and individual behaviour and breeding success in order to help assess the potential noise impacts of the proposed SSC. To do this, the review has attempted to focus on identifying impulsive noise studies for the species of interest on Unst and with the ornithological study area. A variety of freely available data bases were searched including ResearchGate and Google Scholar. References considered included both peer-reviewed published scientific papers and grey literature reports. However, relevant literature was at best limited and so a wider literature search was conducted looking at other species including where possible analogous birds to those present in the SSC ornithological study area.

Helicopter and aircraft noise including military (Jet flyover at 100ft – ~103dB)

Aircraft movements have been shown to alter time-activity budgets of various species of waterfowl as a result of alert responses and increased locomotion in response to noise stimulus (Pepper *et al.* 2003). In response to sudden onset high amplitude noise from military jets (>100dB), harlequin ducks (*Histrionicus histrionicus*) decreased courtship for 1.5 hours and increased agnostic interactions for 2 hours following noise despite direct behavioural responses (head up, startle – flushing, agitated, diving) at the time of the flyovers generally lasting under a minute (Gougie & Jones, 2004).

A study on peregrine falcons (*Falco peregrinus*) found low military jet training had no impact on breeding success rates (Roby *et al*. 2002). However, this study highlighted that impacts of noise on a species may differ between sex; a reduction in male attendance at eyrie's with high jet activity was observed, albeit compensated for by increased female attendance. It was speculated that resultant changes to the female's time budgets may have long term implications for individual fitness. Elsewhere, a study on Wilson's plover (*Charadrius wilsonia*) reported military flights increased birds alertness and scanning behaviour, but with no evidence of effect on heart rate or incubation, or direct evidence of this behavioural response reducing reproductive success (Derose-Wilson *et al.* 2015).

Arctic tern (*Sterna paradisaea*) incubating behaviour is impacted by both fixed-wing aircraft and helicopters, with helicopters causing more disturbance to birds than fixed-wing aircraft, however human presence had a larger effect than aircraft disturbance (reviewed in Manci *et al*. 1988).

Sound levels are important in the determination of whether or not a species is going to respond to a noise stimulus; a small proportion of a colony (<20%) of crested terns (*Sterna bergii*) nesting on the Australian great barrier reef exhibited behaviour indicating that they were preparing to fly away (or actually flying away) in response to aircraft noises when louder than 85dB (Brown, 1990). Such 'upflights' lead to an increase in predation risk of young or eggs, exposure of eggs/chicks to temperature extremes in addition to the energetic cost of the flight to the adult bird.

Not all studies report a reaction to aircraft noise; a study exploring the possibility that increased air traffic associated with oilfields off north-east Scotland was impacting breeding seabirds recorded the reactions of a mixed colony of fulmars (*Fulmarus glacialis*), shags (*Phalacrocorax aristotelis*), herring gulls (*Larus argentatus*), kittiwakes (*Rissa tridactyla*), common guillemot (*Uria aalge*), razorbills (*Alca torda*) and puffins on the Buchan cliffs in relation to aircraft flying within 100m of breeding cliffs. Virtually no behavioural reaction was reported as a result of the flyovers to within 100m of the colony conducted during early egg laying and early nestling periods (Dunnet, 1977). Most of these species are present in, and therefore directly relevant to, the SSC ornithological study area.

The apparent lack of behavioural changes does not necessarily mean there was no impact on fitness; studies of heart rate response to visitor disturbance on kittiwakes and shags (i.e. study not specifically looking at noise) found increased heart-rates of up to 50% with individuals showing extreme variation following disturbance (Beale, 2007); such increases in heart-rate may have implications for energy budgets and thus individual fitness. However, it is worth noting that increased heart rates and stress from, for example, being trapped and handled by licensed bird ringers is not generally considered important in terms of individual (or population level) energy budgets and fitness for most species of birds.

Drawing firm conclusions from one study e.g. the lack of an impact recorded in Dunnet's 1977 north-east Scotland study may not always be replicated elsewhere because individuals from the same species can vary in terms of responses. A recent study on airplane disturbance in California on common murres (aka common guillemot) found that 57% of aeroplane flyovers resulted reactions including head bobbing and flushing (Rojek *et al.* 2007). Guillemots found helicopter flyovers significantly more disturbing with 83% of flyovers resulting in observable disturbance in the same study, despite aircraft being louder, leading to lost eggs and chicks. Extensive head bobbing occasionally resulted in the loss of eggs or chicks, but most egg/chick lost were dislodged during flushing. Reactions to flyovers were dependant on the time of year with guillemots more prone to flushing in the pre-egg and early egg-laying periods than after egg-laying is well underway (Rojek *et al.* 2007). It is worth noting that such egg losses may have been focussed on those nest sites close to cliff edges in sub-optimal locations which may have failed naturally regardless. In other words, such egg losses may not have been additive.

There are several studies on raptor responses to disturbance/noise events. For example, Grubb *et al.* (2010) investigated the response of incubating golden eagles (considered by expert opinion to be the most sensitive UK bird species to disturbance; Ruddock & Whitfield, 2007) to heli-skiing and military helicopters in northern Utah, USA. They watched 303 helicopter passes between 0–3,000m (horizontal distance) in 22 nesting territories and found no effect on early courtship, nest repair or subsequent nesting success. No response occurred in 66% of passes and incubating birds watched helicopters in 30% of observations. Whilst this and other raptor studies are in themselves interesting, their relevance to the situation on Unst is unclear.

The literature does not show any significant difference between bird responses when considering the height of the passing over event; perhaps because substantial adverse responses are so rarely recorded. Elsewhere, helicopters are considered to have more impact on birds than fixed-wing aircraft (despite aircraft being louder), however, it is unclear as to what aspect of the noise is most disturbing to birds (Bowles, 1995), but perhaps due to the slower nature of helicopter flight. Curlew (*Numenius arquata*) roosting on grassland fields are sensitive to helicopter overflights at less than 200m overhead (Smit & Visser, 1993).

Sudden blasts including fireworks & military shooting ranges (fireworks ~ 145dB)

A study of northern cardinal (*Cardinalis cardinalis*), a north American songbird, breeding on military bases (thus exposed to noise disturbance including firing guns, artillery, and ordinance) found no evidence for decreased offspring provisioning or reproduction success between areas of high military activity (tenfold difference on disturbance) and areas elsewhere with lower military activity (Barron *et al.* 2012). Cardinal abundance was not formally tested but was considered similar between high and low disturbance areas. No efforts were made to quantify the levels of noise exposure, thus both sites may have had the same maximum dB levels, just less frequent loud noises in the low activity area, therefore, it’s possible that both high and low activity sites were considered equally disturbed to cardinals - the study would have benefited from a non-military control site. The same study provided evidence that the presence of the military activity suppressed crow activity with use of low activity areas five times that of high activity areas (Barron *et al.* 2012) demonstrating that not all species are equally affected by disturbance.

Golden plover (*Pluvialis apricaria*), a species present in the SSC study area, breeding on Otterburn firing range in England increased from 25 pairs in 1994 to 34 pairs in 1998 despite noise disturbance (Forsdyke, 2004). Despite the increase in breeding numbers, individual golden plover displayed adverse behavioural responses: “*a flock of approximately 50 (non-breeding) golden plover were startled into flight approximately 1,000m ahead of the launcher* *and exhibited a pattern of irregular flight movements characteristic of predator evasion*" in response to missile launches (Forsdyke, 2004).

Occasionally, fleeing behaviour following loud noise exposure can result in breeding failure. For example, adult prairie falcons (*Falco mexicanus*) fleeing nests in response to loud noise (construction blasting) caused some eggs to be knocked from the nest (as reviewed in Larkin *et al.* 1996).

Mass mortality events associated with fireworks have been reported, for example, an estimated 5,000 passerines including European starlings (*Sturnus vulgaris*), common grackles (*Quiscalus quiscula*), red-winged blackbirds (*Agelaius phoeniceus*) and brown-headed cowbirds (*Molothrus ater*) fell to the ground in a 30 minute period in a square mile area in Bebe, Arkansas on one winters' day. Testing conducted by the National Wildlife Health Centre concluded the birds died after suffering from 'blunt-force trauma' following being flushed from roost sites by professional grade (i.e. loud) fireworks and crashing into objects including trees and buildings (National Geographic, 2011).

This phenomenon of being flushed from roost sites following fireworks has also been reported elsewhere, e.g. in Poland where a study of roosting magpies (*Pica pica*) throughout winter found a marked reduction in the numbers roosting following nearby use of fireworks; 30 individuals roosting on New Year's Eve reduced to 5 the day following the fireworks (Karolewski *et al.* 2014). Although no direct mortality was reported, the loud noise impacted the bird's choice on returning to the area over a temporal scale beyond 24 hours, suggests a possibility of breeding territory abandonment in response to sufficiently loud noise impulsive.

Although most of the above cases relate to passerines, this phenomenon of loud bangs from fireworks causing disturbance has also been reported for some waterbirds (Shamoun-Baranes *et al.* 2011) and auks (Weigand & McChesney, 2008). Monitoring by U.S. Fish and Wildlife Service and the Bureau of Land Management of pelagic cormorants (*Phalacrocorax pelagicus*), pigeon guillemots (*Cepphus columba*), western gulls (*Larus occidentalis*), black oystercatchers (*Haematopus bachmani*) and Brandt's cormorants (*Phalacrocorax penicillatus*) nests on costal rocks in California found some nests were abandoned, following a nearby fireworks display (Weigand & McChesney, 2008).

Non-breeding curlew on the Humber estuary in England at a high tide roost changed behaviour (alertness etc.) in response to an experimental blast noise but not taking flight at noise levels of approx. 72dB, taking off but returned quickly at noise levels of approx. 76dB, taking off and leaving the area at values of 80dB (Wright *et al.* 2010). High levels of individual variation were observed in responses to the airhorn blast noise stimulus. Golden plover appear more sensitive than curlew to the airhorn blasts, changing behaviour (alertness etc.) but not taking flight at noise levels of approx. 69dB, taking off but returning quickly at noise levels of approx. 74dB and taking off and leaving the area at values of 80dB (Wright *et al.* 2010). Note these wader responses were measured outwith the breeding season, thus perhaps the birds were not as invested in the location as they would be if on their breeding territory. Breeding birds have been shown to be tolerant of much louder blasts e.g. an experimental 138dB trial blast on Christmas Island in the vicinity of red-footed boobies (*Sula sula*) (a species similar to gannet) recorded no behavioural response other than an increase in the apparent vigilance of chicks (Environment Australia, 2000). This blast was carried out as part of and EIA for a proposed rocket launch facility.

Space centres and birds

Space centres can hold good breeding populations of birds, many of them declining species and conservation priorities. For example, the land immediately adjacent to the Kennedy Space Centre in Floirida, USA, is home to large breeding populations of wetland/wading birds (Smith & Breininger, 1995), despite being exposed to irregular loud impulsive noise events.

Populations of certain species of birds are considered problematic at the Kennedy Space Centre; following a bird strike (by a vulture) damaging a launching shuttle's external tank after liftoff, NASA implemented a policy of removing roadkill on the infrastructure leading towards the space center in order to reduce the numbers of vultures in the area (Schlierf *et al.* 2007). Monitoring of reproductive success rates of endangered Florida scrub jay (*Aphelocoma coerulescens*) breeding near launch pads found comparable success to those further away (Breininger *et al*. 1994). An Environmental Assessment for heavy launch vehicle programs from a space launch complex at East Vandenberg Air Force Base, California reviewed the literature on the impact of noise on western snowy plover (*Charadrius nivosus nivosus*) (a similar species to ringed plover). It concluded wintering western snowy plover during Titan IV launches (130dBA) did not exhibit any adverse reactions to the launch, and monitoring during the breeding season recorded no injury or mortality to adults, young, or eggs following smaller launches and concluded behaviour was not adversely affected by launch noise or vibrations (Space Exploration Technologies, 2011). However, impacts of rocket launch noise have been demonstrated for some species; a launch in California in July 1997 resulted in losses of least tern (*Sternula antillarum*) eggs and chicks including 4-5 nests on eggs and one nest containing two chicks breeding within 650m of the launch site (Schultz, 1997). The severe disturbance of the launch combined with predation attempts by owls likely contributed to the observed early seasonal departure from the site by the remaining adult least terns.

SSC noise and birds

Taking into account evidence from the literature above, it is apparent that loud infrequent noise associated with rocket launches could be expected to impact on birds in the vicinity of the proposed development. Less clear, are the ecological effects and consequences of the short duration loud disturbance impacts on birds. Birds closer to the launches are predicted to be at higher risk of noise impact. Depending on how far away individuals are from the noise, the birds can be expected to either not react (best-case scenario), freeze, and/or become agitated or flee and die (worse-case). The short-term loud noises experienced during a rocket launch could potentially result in either or both physiological and behavioural changes in those individuals experiencing the noise. However, most studies consider potential impacts and do not show or demonstrate long-term population level effects or consequences.

Changes in behaviour may lead to longer term impacts on the local population (although this is rarely, if ever, empirically demonstrated in published studies) if breeding failure or a reduction in success occurs. Behavioural responses are expected to vary according to species, and even within a species. For example. individual variation in response to human disturbance has been documented in red-throated divers (*Gavia stellata*) (Bundy, 1976), a species present in the SSC ornithological study area. The infrequent nature of the event should reduce the potential magnitude of the impacts, conversely, the irregularity of the noise might prevent the birds from becoming habituated to the disturbance.

The impact of noise disturbance has potential to negatively impact breeding attempts. The following impacts on breeding birds may occur; reduced suitability of breeding habitat in vicinity of the launch facility, deterring birds from settling to breed and increased risk of breeding attempt abandonment (temporarily or permanently) through startle events. Such startle events causing parents to flee may result in increased predation risk in nests temporarily unattended, crushing or dislodgement to both eggs or nestlings, loss of eggs/chicks following exposure to adverse weather, reduced numbers of young fledging or reduced quality (e.g. weight) of young fledging impacting on post fledging survival. The time period for which these affects may occur will be dependent on the breeding phenology of each species in relation to the time of satellite launches, with impacts during egg-laying and incubation likely to be more severe than during chick rearing, when adult parents have developed familial bonds with their offspring. Although empirical data to back this up is limited, the available literature suggests noise impacts may be greatest during the early breeding season when parental investment in the breeding attempt is low.

The loud noise from the launch itself is not expected to directly result in hatching failure through mechanical damage to eggs, an experiment carried out on 20 hen and 20 quail eggs exposed to a loud noise peaking at over 170bD showed no physical damage/cracking (Bowles *et al.* 1991). Additionally, the same experiment found no significant difference in hatching success rate or weights compared to control eggs. Hatch weights have been demonstrated to be important to whimbrel (*Numenius phaeopus*) breeding on Shetland where heavier brood weight was found to be associated with the proportion of the brood surviving to fledging during two breeding seasons (Grant, 1991). Although there is no direct evidence of mechanical damage to eggs due to loud noise, the absence of research regarding the effect of exposure to loud noises on developing embryos hearing has been highlighted (Larkin *et al.* 1996).

Rocket launches in Scottish Special Protection Areas (SPA)

The following two locations are operational military sites in Scotland where live fire exercises have taken place for decades. Both locations lie within and adjacent to internationally important designated sites for birds that are also present within the SSC ornithological study area.

Hebrides Range (Benbecula)

South Uist missile range (also known as Hebrides Range) lies on the northwest part of the island of South Uist, together with its local radar tracking station, immediately to the south of the island of Benbecula. According to Jimmy Slaughter (Operations Support – Ground, Shetland Space Centre and a former Artillery Officer, who has fired at Hebrides Range), "*the MOD fire Rapier missiles at the Hebrides ranges on Benbecula and also the HVM (High Velocity Missile) system has been fired there in the past. The Navy do test fire some of their air defence missiles, but these will be fired from the sea. The RAF also test fire over the sea: they fire the Meteor (which is fired from the Typhoon) and ASRAAM (an air-to-air missile) nearby. The range is in use roughly 35 weeks of the year*". The use of the Hebrides Ranges appears to have risen recently, in terms of the number of different types of missiles launched (https://www.pressandjournal.co.uk/fp/news/1634218/natos-growing-use-of-island-missile-testing-range-revealed/). Data released to the Press and Journal in 2019 shows that 12 different types of missile were used at the facility in 2017/18. The Hebrides Range includes part of the South Uist Machair and Lochs SPA, a 5,027ha designated site for birds.

According to SNH SiteLink (accessed August 2020) "*South Uist Machair and Lochs SPA is a complex site along the west coast of South Uist. The west coast of South Uist is of outstanding importance for its transition of habitats from the acidic moorland to the* *calcareous coastal plain, and for the transition from freshwater habitats to saltwater habitats. This complex includes outstanding examples of (moving seawards), relict woodland, moorland and blanket bog, large oligotrophic lochs, acidic blacklands, wet and dry machair with eutrophic machair lochs, freshwater marsh, saltmarsh, coastal dunes and sandy and rocky shores. These areas are of outstanding importance for their populations of wintering and breeding waterfowl and for their breeding population of corncrakes associated with traditional crofting practices*".

"South Uist Machair and Lochs SPA qualifies under Article 4.1 by regularly supporting populations of European importance of the Annex 1 species: corncrake (1992 to 1994, 20 calling males, 4% of the GB population); little tern (1986 to 1990, 31 pairs, 1% of the GB population) and dunlin (1995, 357 pairs, 4% of the GB population).

"South Uist Machair and Lochs SPA further qualifies under Article 4.2 by regularly supporting populations of European importance of the migratory species: ringed plover (1995, 393 pairs, 3% of the Europe/Northern Africa biogeographic population; and, during 1993/94 and 1994/95, up to 490 wintering individuals, 1% of the same biogeographic population); redshank (2007, 379 pairs, 1.3% of the Eastern Atlantic biogeographic population); oystercatcher (2007, 629 pairs, 0.2% of the Europe & Northern/Western Africa biogeographic population, and selected as one of the most suitable sites for oystercatcher in GB with 0.6% of the GB population) and sanderling (2004, 667 wintering individuals, 0.6% of the Eastern Atlantic/Western & Southern Africa biogeographic population, and selected as one of the most suitable sites for sanderling in GB with 4% of the GB population)".

According to SNH SiteLink, aside from land acquisition for a 0.2ha area called Stilligarry, there are no management agreements for this site, which presumably means that the military activity undertaken (rocket launches, live fire etc.) within the SPA is not seen as threat to the designated site bird species or site integrity. Dunlin and ringed plover are both present within the SSC ornithological study area.

<u>Cape Wrath (Sutherland)</u>

According to Jimmy Slaughter (Operations Support – Ground, Shetland Space Centre and a former Artillery Officer, who has fired at Cape Wrath) "*Naval and Artillery live firing does take place there as well as mortar fire from time to time too. All ammunition natures (high explosives, smoke and illumination) are fired. An Garbh-eilean (Garvie Island), just off the coast, also gets a fair share of high explosives courtesy of numerous NATO air forces, including our own. In addition, small arms firing takes place at Cape Wrath*". Firing takes place during the bird breeding season (https://www.gov.uk/government/publications/scotland-firing-times; accessed August 2020). "*The RAF drop 1,000lbs bombs on to Garvie Island*", which is within the Cape Wrath SPA, a 6,737ha site (although the island itself is within the SPA, it appears excluded from the designated site map).

According to SNH SiteLink (accessed August 2020) "*Cape Wrath SPA covers two stretches of Torridonian sandstone and Lewisian gneiss cliff around Cape Wrath headland in north west Scotland. These cliffs support large colonies of breeding seabirds. The boundary of the SPA overlaps with the boundary of Cape Wrath SSSI, and the seaward extension extends approximately 2km into the marine environment to include the seabed, water column and surface*".

"*Cape Wrath SPA qualifies under Article 4.2 by regularly supporting in excess of 20,000 individual seabirds. It regularly supports 50,000 seabirds including nationally important populations of the following species: kittiwake (9,700 pairs, 2% of the GB population), common guillemot (13,700 individuals, 1% of the GB population), razorbill (1,800 individuals,* *1% of the GB population), puffin (5,900 pairs, 1.3% of the GB population) and fulmar (2,300 pairs, 0.4% of the GB population)*".

According to SNH SiteLink, there are no management agreements for this site, which presumably means that the military activity undertaken (rocket launches, live fire, including bombing etc.) within the SPA is not seen as threat to the designated site bird species or site integrity. Kittiwake, common guillemot, razorbill, puffin and fulmar are all present within the SSC ornithological study area.

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Appendix 5.3 SaxaVord Spaceport Detailed Habitat Management Plan

SaxaVord Spaceport:
Detailed Habitat Management Plan Part I
Non-confidential elements

Alba Ecology Ltd.

Loomer Shun peatland restoration area

February 2022

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Introduction

Unst Space Port Ltd., is committed to establishing, implementing and funding an agreed Habitat Management Plan (HMP) for the lifetime of the proposed SaxaVord Spaceport (formerly called Shetland Space Centre). The detailed HMP has been prepared to set out how the Applicant will enhance ecological interests through the construction and operation of SaxaVord Spaceport and is based on the Outline Habitat Management Plan (OHMP) which was prepared and submitted to Shetland Island Council (SIC) as part of the Environmental Impact Assessment Report (EIAR) in 2021.

Whilst priority biodiversity has been the main focus of the HMP actions, they also afford substantial opportunities for tie-ins with carbon offsetting, wildlife-related tourism and local community enjoyment of nature.

SaxaVord Spaceport provides the basic infrastructure for space vehicle launches which may in the future conceivably develop and evolve with emerging technologies and commercial demands. Although the development does not have a pre-determined operational lifespan, it is anticipated to be operational for at least 30 years. When decommissioning of the SaxaVord Spaceport eventually takes place, a separate Decommissioning Management Plan will be prepared (using current best practice at that time) that will commit SaxaVord Spaceport to ensure that the decommissioning works can be completed so as to continue to deliver the objectives of the approved HMP.

Having considered the potential and likely impacts and effects of the proposal, we believe this HMP provides sufficient ecological benefits to offset adverse ecological impacts for a potential development of this nature and scale and that it provides additional wide-ranging ecological enhancements that supports relevant policy objective e.g. SPP and NPF4.

The SaxaVord Spaceport has promoted the inclusion of a planning condition that will secure the development and implementation of the HMP and ensure its full and effective delivery.

Aims and Objectives

The HMP has the following overall aims:

- Aim 1: To enhance habitats for species of importance present on, or linked to, the Study Area (as defined in the EIAR).
- Aim 2: Restore important habitats and associated species.

These aims were given an objective in the OHMP which were:

- Objective 1: Create a wildlife watching hide on Lamba Ness.
- Objective 2: Peatland restoration.
- Objective 3: Create native riparian broadleaf tree/scrub cover.
- Objective 4: Coastal grassland habitat management.

All potential HMP management areas have been surveyed and assessed for suitability and to ensure that any existing important biodiversity is protected and considered when developing and implementing the approved HMP. Most HMP works will be undertaken between September and late March (inclusive) to prevent the possibility of disturbing nesting birds. However, if works do take place outside this period, then measures will be put in place to ensure no significant disturbance of sensitive/legally protected species occurs.

Objective 1. Create a wildlife watching hide on Lamba Ness

Current situation

The eastern most tip of Lamba Ness has long been recognised as one of the best locations in Shetland to watch seabirds and cetaceans. During informal discussions with local birdwatchers and whale watchers a concern was raised that access to the favoured tip of Lamba Ness might be curtailed by the development of SaxaVord Spaceport. The existing and best wildlife watching location is at HP 67502 15654 and is very exposed to the elements, with the only shelter (which is partial) provided by one of the existing old RAF buildings, which itself would be within the SaxaVord Spaceport fenced off area and so not utilisable in the future.

The suggestion was made by local birdwatchers that a purpose built wildlife watching hide, with guaranteed access (except around launch days) would allay such fears and be a welcome addition to facilities on Unst. The proposed hide location needs to be as close to the edge of the rocky area identified below as possible and would be partly on the rocky projection and the also party on the grass (Photo 1). The arrows marked on the following series of photos show the indicative direction looking out of the hide.

Wildlife hides in the wrong place or facing in the wrong direction are not usable and a wasted opportunity. Based on hundreds of hours of bird and whale observations, the hide must be at this precise location (HP 67502 15654) and face the direction illustrated on photos for it to work observationally. There are no worthwhile alternative locations due to the greater height of the cliffs, access, direction/angle of the sun and geographical position of all other potential locations. Currently, whale watchers and bird watchers sit on the grassy step (broadly where the base of the arrow marked in Photo 3 is) and look out to sea. Most seabirds pass this point very closely and bypass the other areas in and around Lamba Ness. The whales and dolphins tend to congregate in the zone of water mixing ca. 300m off this location, although killer whales/orcas are usually much closer in, hunting seals along the shoreline.

Photo 1. View onto downslope proposed hide location, 2020.

Photo 2. Angled view from south looking onto proposed hide location, 2020.

The hide location is regularly used by local residents and visitors for bird and whale watching currently. The shelter afforded by a hide in this windswept and exposed location means it would be well used and very likely to become a valued community and tourist facility. Given visiting groups of up to 12 people would likely use the sea-watching hide, it should aim to be able to accommodate ca. 12-15 people.

Photo 3. Angled view from north onto proposed hide location, 2020.

Photo 4. Reverse view from proposed hide location, looking back inland towards existing old RAF buildings, 2020.

Delivery

The provision of a wildlife hide along with a footpath/track have been included in the design layout (Figure 1).

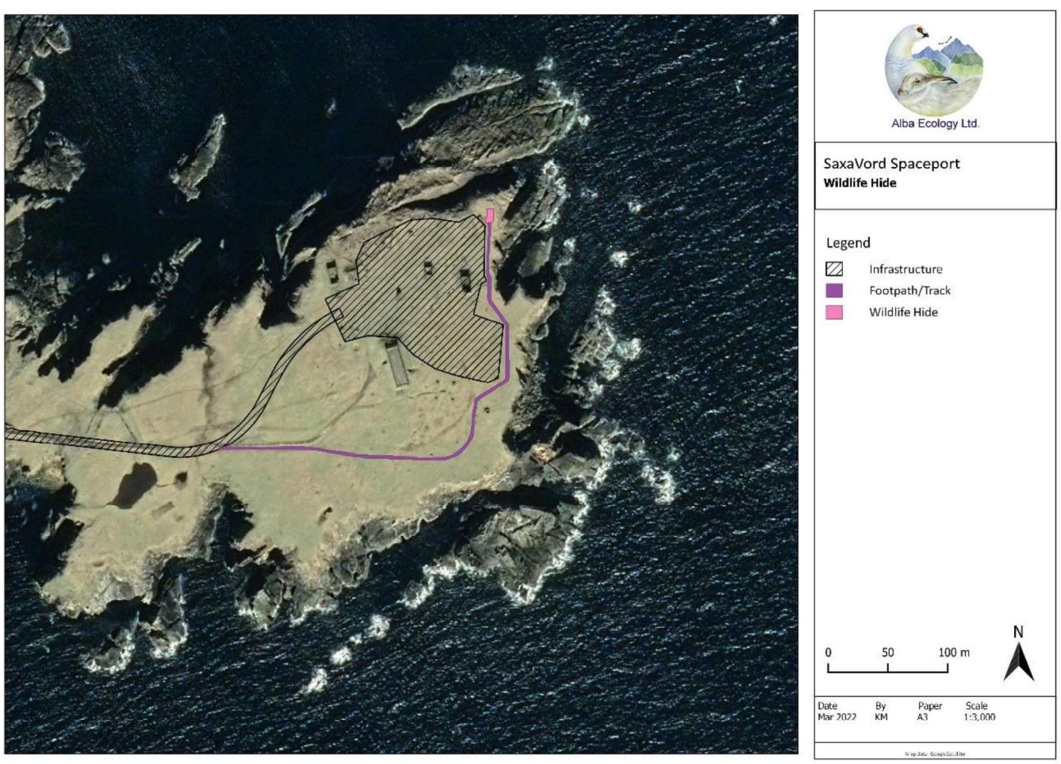

Figure 1: Location of Wildlife Hide on Lamba Ness

The location of the proposed wildlife hide is on land managed by SaxaVord Spaceport and so the work will be guaranteed to be taken forward. The Applicant has been willing, and continues to be open to potential community ownership of the wildlife hide whilst contributing to an annual maintenance budget for hide repairs and improvements. A footpath along the edge of the Saxa Vord Spaceport boundary fence will provide access from the public road (Figure 1).

Ideally, a wildlife hide should enable easy and ample viewing for seated observers using both binoculars and telescopes not looking through glass. Designs of sea-watching hides are varied, but whatever design is used, it needs to be robust to withstand the autumn and winter storms on Unst. Typical 'standard' wooden bird hides would not be suitable as they would likely be damaged or destroyed during storms. Consequently, some sort of stone structure will probably be necessary. Detailed plans of a sea-watching hide recently constructed at Flamborough Head, Yorkshire can be viewed here. A few more sea-watching hide designs can be viewed here. The stone-built wildlife hide at Whitburn, County Durham was purpose built in 1990 and has withstood the tests of time and weather since then.

In summer 2022, SaxaVord Spaceport will consult with local stakeholders e.g. Unst resident birders and whale watchers and agree a suitable design for the wildlife hide, after which, the hide will be built as soon as suitable materials are available in 2022.

Objective 2. Peatland restoration

Areas of blanket bog within north Unst have historically been subject to peat cutting and other pressures such as grazing by sheep combined with extreme weather. This has led to a noticeable deterioration in the condition of the blanket bog habitat, with erosion features and impacts of drainage on the blanket bog reducing its ability to support species of conservation importance such as red-throated diver.

The OHMP identified peatland restoration as a key objective. In the intervening time between the OHMP being written and consent being granted the location and type of peatland restoration has been amended. In February 2022 an outline of proposed peatland restoration plan was provided in a confidential document entitled "*A Summary Report Outlining Peatland Restoration Proposals for Unst Space Port*".

Three indicative peatland restoration areas were identified in north Unst (Figure 2). Loomer Shun was identified as suitable for peatland restoration and peat re-use from the construction of the Saxa Vord Spaceport. Peat re-use is considered in more detail in the Peat Management Plan (PMP). Skaw Paet Hoose and Ritten Hamar were both sites identified for peatland restoration (without peat re-use from the construction of the SaxaVord Spaceport).

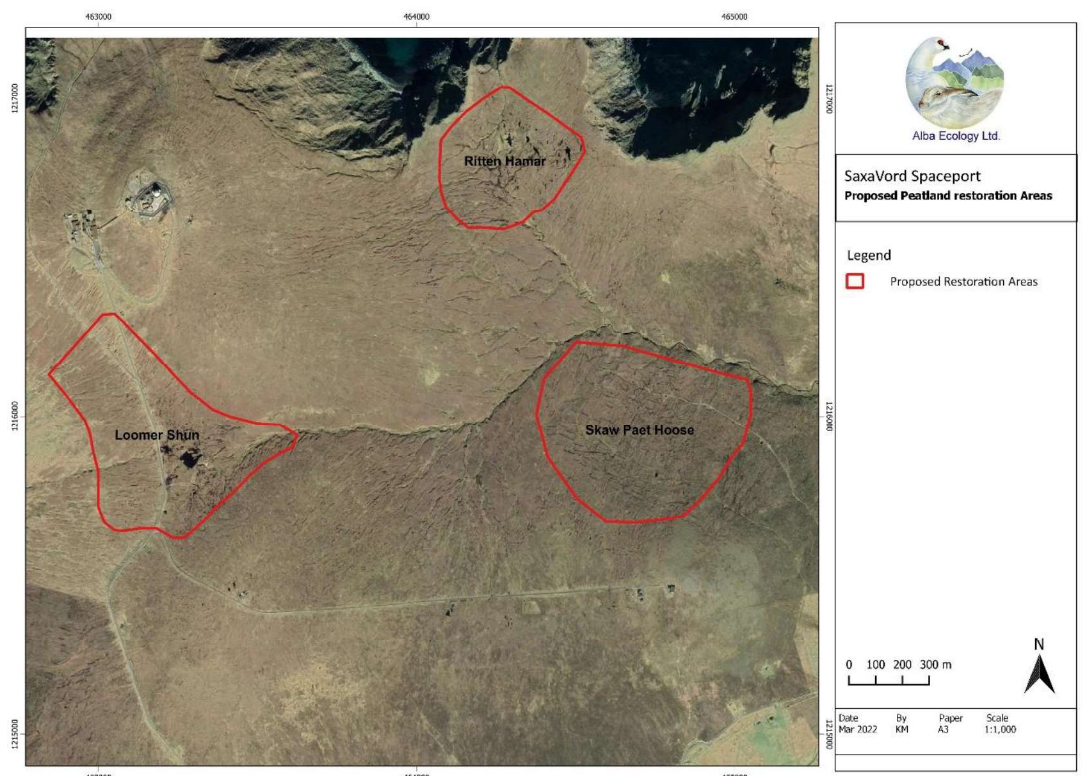

Figure 2: Indicative Peatland Restoration Areas

Current situation – Loomer Shun

The area that is termed 'Loomer Shun' in Figure 2 is a ca. 20.7ha area between the hills of Saxa Vord and Sothers Field. It is made up of modified bog habitat which has been widely cut for peat, both historically and more recently. The recently cut peat had bare peat faces are ca.1m-1.5m in height with fresh exposed peat on the face and for ca. 1m on the cut base. Where the peat had been historically cut there was evidence of further wind and rain erosion resulting in undercuts with dry vegetation overhanging the cuttings. Sheep clearly use the cuttings as shelter during inclement weather and whilst doing so have caused erosion locally around the lochan area. Further down the hillslope, to the east, the bog vegetation appeared to have a more naturally eroded pattern from wind and rain action likely exacerbated from sheep. As detailed in the OHMP, the lochan at Loomer Shun is considered to be at risk of being lost through water drainage.

Photo 5: Loomer Shun, peat cut and eroded to mineral soil in the foreground. Older peat cuttings and erosion in the background.

Baseline conditions – Loomer Shun

A site visit and Peatland Condition Assessment (PCA) was undertaken at Loomer Shun in February 2022.

PCA surveys are a standardised, if basic, method for assessing the condition of peatland habitats. The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of management activities such as grazing, peat cutting and burning (Peatland Action, 2016). The PCA recognises four categories of peatland condition:

1. Near-Natural - peat forming bog-mosses dominant, with no recent fires, little or no grazing pressure and little or no bare peat, heather is not dominant.
2. Modified – bare peat is in small patches, fires may be recent, grazing impacts are evident, bog-mosses are absent or rate, extensive cover of heather or purple moor-grass.
3. Drained – within 30m either side of an artificial drain or a revegetated hagg or gully system.
4. Actively Eroding – actively eroding hagg/gully system, extensive continuous bare peat surfaces.

Figure 3 provides an indicative PCA map (based on a site visit and aerial photos). All of the peatland was classified as Modified and Drained, largely through peat cutting but also through some more natural erosion features, likely from a combination of sheep and wind and rain action. There were areas that were actively eroding and this included the cut faces and erosion feature faces which had exposed peat.

The total length of peat cuttings at Loomer Shun (based on aerial photos) was estimated to be ca. 3.2km[1].

The total length of erosion features at Loomer Shun (based on aerial photos) was estimated to be ca. 0.8km.

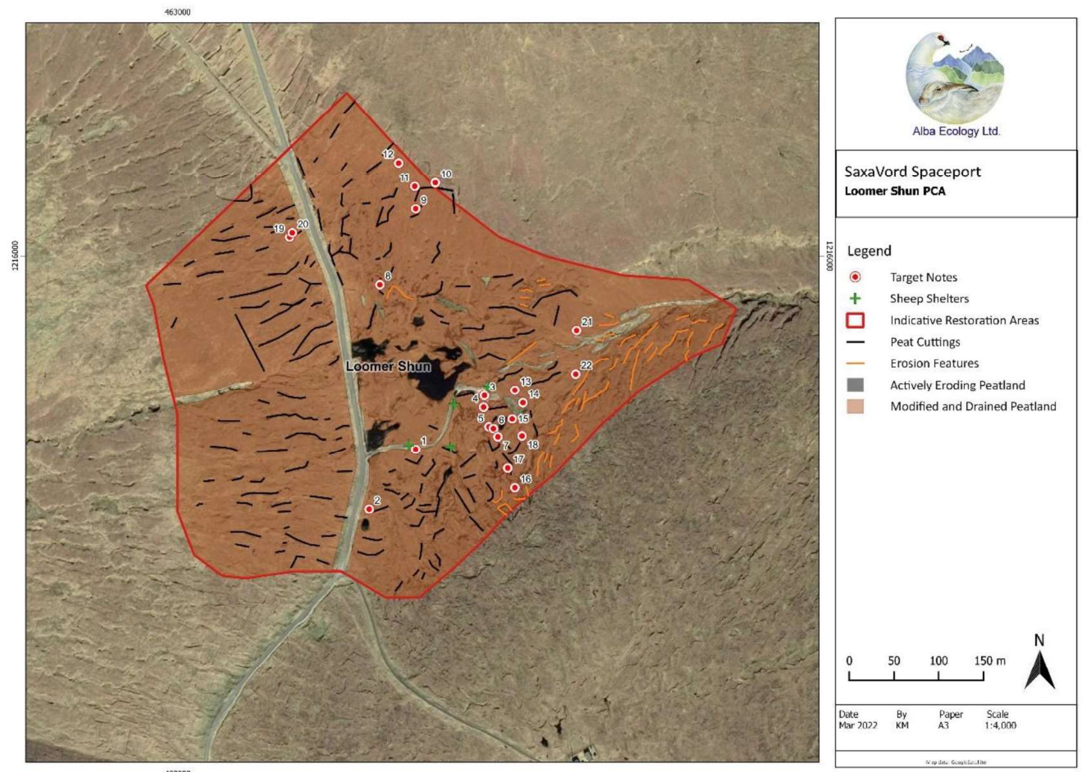

Figure 3: PCA and Target Note locations for Loomer Shun

There were three key habitat types mosaiced within the peatland at Loomer Shun;

- Modified and drained bog at the original bog surface;
- Modified bog that had revegetated at the base of the cut surface where the remaining peat was >0.5m; and
- Acid grassland/wet heath vegetation that had revegetated at the base of the cut surface where the peaty soils peat was <0.5m.

The modified bog at the original bog surface was usually dry, with heather and crowberry common with common cottongrass and species such as glittering wood moss. Patches of bog-

[1] Note that these metrics and locations shown in Figure 3 are based on aerial images, viewed between 1:2,000 and 1:4,000 and have not been fully ground truthed. It is possible some 'peat cuttings' are actually 'erosion features' and visa versa. Lengths are estimates only.

moss were occasional. This was the original surface, where peat has been cut away, leaving exposed drying and eroding edges or in some places more natural forms of erosion were present. It was hydrologically disconnected from other section of bog habitat, due to the peat cutting; this results in a form of dry heath vegetation forming over the deep peat.

The modified bog that had revegetated at the base of the cut surface where the remaining peat was >0.5m was generally damper underfoot than the original bog surface vegetation. Common cottongrass was the dominant vascular plant, but there was also heather and hare's-tail cottongrass. Bog-mosses were frequent and included red bog-moss and papillose bog-moss.

The acid grassland/wet heath vegetation that had revegetated at the base of the cut surface where the peaty soils peat was <0.5m was generally dominated by either mat grass or heather with common cottongrass, depending on the thickness of the peaty substate. In some places these areas went down to mineral soils.

Table 1 provides details of the baseline through a series of Target Notes of the peatland habitats at Loomer Shun. The locations of the Target Notes are shown in Figure 3.

TG	Grid	Note	Photo
1	HP 63266 15784	Recent peat cutting area, which was ca. 15m x 15m in size. The cut face was ca. 1m high. There was ca. 0.3m of soil below the cut surface which had revegetation to form wet heath with abundant bog-moss. It is considered that this is suitable for infilling with peat. The level of revegetation, post peat cutting, demonstrates that the bog will likely recover from restoration and the current sheep densities have not prevented the natural revegetation of these areas.	 
2	HP 63214 15717	Peat cutting is common in this area. This old cutting was well vegetated. It was ca. 0.5m high. Bog mosses were present at the base of cuttings.	

TG	Grid	Note	Photo
3	HP 63343 15844	In the central area, where the vehicle track ends, the peat had been historically cut leaving shallow soils (0-0.5m deep) with acid grassland, wet heath or bare mineral soils/bedrock. There was remanent dry bog surrounding this area demonstrating where the original bog surface would have been. The cut faces were ca. 1m-2m high and actively eroding.	 
4	HP 63342 15831	Recently cut peat. The cut face was ca. 0.5m-1m deep. Potential area for filling with peat from construction. There were shallow soils at the cut surface which had revegetated with acid grassland and wet heath. The surrounding, original bog has been drained from the cut feature. There was heather, common cottongrass and crowberry with occasional patches of bog-mosses present in this area.	 

TG	Grid	Note	Photo
5	HP 63348 15809	Although much of this area is not the original bog surface, some pools were formed within the cut surface. This wet area was ca. 0.5m deep. There were cutting features ca 1.5m high around this feature, showing where the peat had been historically removed. The regenerating vegetation on the cut surface demonstrates the potential for bog vegetation to re-establish successfully.	 
6	HP 63353 15807	Ca. 10m x 10m patch of bare peat. Eroded to mineral soil at the lower end, and 5m deep at the top end. The bare exposed peat was actively eroding.	
7	HP 63358 15798	Views of peat cuttings across Loomer Shun. The cuttings in the distance look appropriate for infilling. The surface vegetation will be lifted up first, suitable peat added and then the surface will be laid back down. The PMP provides more information for this peat re-sue.	 

TG	Grid	Note	Photo
8	HP 63226 15968	This area had old cuttings. The cut faces of the cutting had eroding edges giving a more ‘natural’ look. Between these peat cuttings there was deep peat (ca. 1.5m deep), with bog-moss rich vegetation. These areas would be suitable for reprofiling, to prevent drying and hydrologically link the bog.	 
9	HP 63266 16053	This old peat cutting was ca. 1m in height. There was deep peat (ca. 1m) below the cut surface, which had revegetated with some small hummocks of bog-moss.	
10	HP 63288 16082	Deep peat underlies the cut surface vegetation. The remaining peat was ca. 1m deep and there were wet areas. The cuttings were ca. 1m deep. This demonstrates that the bog vegetation will establish successfully after restoration.	
11	HP 63265 16078	View across Loomer Shun.	

TG	Grid	Note	Photo
12	HP 63247 16104	This recent peat cutting was ca. 1.5m deep and ca. 10m long. There was 0.5m of peat at the cut surface. The cut surface had revegetated with acid grassland and wet heath.	
13	HP 63377 15850	There was a large bowl-shaped historic cutting area which was ca. 30m x 50m in size. The cut faces were ca. 1m-2m in height reaching to the original bog. The cut surface had ca. 0.5-0.6m deep peaty soils which was revegetated. Suitable for infilling.	
14	HP 63386 15836	There were occasional pools with feathery bog-moss in them. However, this one was only ca. 0.5-0.6m deep.	
15	HP 63374 15818	Here the peat cutting went down to mineral soil. This was within the main bowl-shaped historic peat cutting. The original bog surface was ca. 2m higher. Suitable for infilling.	

TG	Grid	Note	Photo
16	HP 63377 15741	Peat cutting. Generally shallow soil at base of cutting, cut faces ca. 1m in height.	 
17	HP 63369 15763	Infilling would be suitable in all this modified bog habitat.	
18	HP 63385 15799	This area was clearly modified through peat cutting and subsequent drying of the original bog surface. Common cottongrass, heather and crowberry were the most common species with patches of flat-topped bog-moss. There was ca. 1m of peat below the cut surface, which was in generally good condition, demonstrating that the bog vegetation would recover successfully after restoration.	
19	HP 63125 16021	There were number of old peat cuttings on this side of the road. There was ca. 1m of peat below the cut surface, which was well vegetated. The cuttings were ca. 1m high with the original bog surface lined with heather demonstrating an associated drying effect of the cutting.	

TG	Grid	Note	Photo
20	HP 63128 16026	There were peat cuttings along the road for ca. 400m and ca. 50m wide from the road. The cuttings were regularly cut to ca. 1m–1.5m. The remaining cut surface was well vegetated, demonstrating a high chance of successful restoration. There was ca. 1.2m peat below the cut surface.	 
21	HP 63446 15917	There were what appeared to be ‘natural’ erosion features at this location. They were ca. 1m-2m in height. There was bare exposed, eroding peat of the hagg face. Suitable for reprofiling.	 
22	HP 63445 15868	There was a ca. 2m high erosion feature at this location with exposed peat actively eroding.	

Table 1: Target notes for Loomer Shun

Delivery – Loomer Shun

There is suitability at Loomer Shun for careful and sensitive peatland restoration, including around the main lochan (as detailed in the OHMP) and more widely, particularly in the areas of current and historic peat cutting. This peatland restoration would include effectively re-using peat extracted from the construction of SaxaVord Spaceport.

In addition to plugging the outflow areas of the main lochan to prevent water draining away, two main peatland restoration techniques will be suitable at Loomer Shun:

i. Infilling the peat cut areas with peat from the construction of SaxaVord Spaceport; and
ii. Reprofiling of cut peat edges.

Best practice techniques for peatland restoration techniques have been developing rapidly, therefore discussions with an experienced peatland restoration team is recommended prior to restoration work commencing. The peatland restoration techniques of infilling and reprofiling were discussed in detail on-site and off-site with local crofters at Loomer Shun. At least one of the local crofters (contact details available upon request) has completed practical peatland restoration work across Viking Wind Farm for the last 1.5 years using the best practice peatland restoration techniques discussed and he considered the proposed methods to be appropriate and suitable for Loomer Shun.

Loomer Shun is considered suitable for peat re-use from the construction of SaxaVord Spaceport for both ecological and practical reasons. There is a public road which provides access from the construction area to the Loomer Shun peatland restoration area ensuring that peat can be quickly and effectively moved without the need for road construction. The peatland restoration which re-uses the peat from construction of SaxaVord Spaceport is detailed further in the PMP.

Infilling: The vegetation on the historically cut bog surface would be carefully stripped ensuring there was sufficient material to retain roots. Peat won from the construction of SaxaVord Spaceport would be used to infill the cutting, raising the level of cutting back to the height of the original bog surface and meeting the height of the surrounding bog. The stripped vegetation would then be carefully placed back on top of the peat. In some areas careful contouring will be required to ensure levels meet the surrounding surfaces. This infilling technique would be particularly suitable where peat has been cut/eroded to the underlying mineral soil layer. Also, this technique would lend itself to historically cut areas where the remaining vegetation and peaty soils/peat depths were relatively shallow.

Photo 6: Recent peat cutting at Loomer Shun suitable for infilling.

Photo 7: A view of historic peat cuttings at Loomer Shun suitable for infilling.

Reprofiling: The edges of historical peat cuttings and erosion features can be reprofiled. Reprofiling is a mechanism for lowering the gradient of the hagg or cut face, and covering the bare peat of the hagg or cut face with vegetation, stretched from nearby existing vegetation (i.e. using the vegetation on adjacent bog at the top of the hagg/cutting and stretching this over the hagg/cutting face). Appendix 1 provides some details on best practice peatland restoration techniques including reprofiling.

Photo 8: A peat cut area at Loomer Shun with deep peat remaining and bog vegetation established. Suitable for reprofiling or infilling.

These peatland restoration techniques will deliver a series of ecological benefits to the Loomer Shun area. They will: halt the current erosion on bare peat faces through wind and rain erosion; halt the bare peat faces losing mass through microbial decomposition; and reduce drying out of the remnant adjacent blanket bog. This will stop the Loomer Shun area from being an atmospheric carbon source. Furthermore, these restoration techniques will wet-up and hydrologically link the existing bog vegetation, which is currently fragmented, and allow a more natural surface pattern and hydrology to develop. In turn, this will benefit the species that rely on wet bog vegetation such as craneflies and other insects, which further benefit associated bird species. This hydrologically linked wet bog will likely deliver additional carbon sequestration as the bog-mosses and bog vegetation form peat over a wider area, locking carbon into the peatland habitat. Hence, the Loomer Shun area would be transformed from being a source of carbon, to potentially an area with widespread carbon sequestration (i.e. a carbon sink).

The crofters (who we understand hold the peat cutting rights to this area) have agreed to a permanent cessation of peat cutting at Loomer Shun. This secures the long-term effectiveness of restoring the peat and blanket bog in this currently degraded area.

The crofters currently have a low level of sheep grazing across Loomer Shun and the wider hill area (estimated at about one ewe per ha by the crofters in 2022). Current grazing levels are not having a noticeable detrimental impact on the wider bog vegetation. For example, there was no evidence of sheep causing or widening bare peat areas and there was wide-scale evidence of the blanket bog restoring itself within the historical peat cuttings. Current sheep impacts are limited to around the lochan and locally at the edges of the peat cutting faces.

Peat cutting removes the bog surface and leaves bare peat. However, much of Loomer Shun, which has clearly been peat cut for generations, was revegetated demonstrating that the current grazing conditions are suitable for revegetation. This was particularly evident where deep peat remained in the cut areas and blanket bog vegetation had re-established and included a variety of bog-moss species. Therefore, it is considered unnecessary to further reduce sheep numbers, although a written commitment to not increase sheep numbers from current base-line levels would ensure the maintenance of low levels of grazing.

Sheep clearly use the erosion/cutting features as shelter in the not inconsiderable winds, particularly around the lochan. Therefore, ensuring shelter for sheep present at Loomer Shun would be essential. This could be achieved by carefully contouring some of the erosion features to be vegetated but still provide shelter, alternatively, or in combination, it could be achieved by providing man-made shelters. Manmade sheep shelters are used commonly across Shetland, including on Unst. An example from Unst is shown in Photo 9.

Photo 9: A artificial sheep shelter designed to provide shelter from different wind directions, Norwick, Unst.

Indicative locations for sheep shelters are provided in Figure 3, although this should be discussed and agreed with crofters and the contractors at the time of the restoration works.

Careful consideration of the timing of this work will be needed to avoid breeding bird disturbance and to prevent further erosion from the wind exposure. Works for peatland restoration at Loomer Shun are scheduled to begin in August-September 2022, after the bird breeding season.

Peatland restoration work at Loomer Shun will be undertaken under the supervision of an appropriately trained ecologist.

A baseline monitoring survey measuring species composition, vegetation height, peat depth and areas of bare peat will be undertaken prior to the peatland restoration beginning at a range of monitoring and control sites around Loomer Shun. The changes to the vegetation/peat will then be monitored at regular intervals, using standardised systematic methods.

The specific objective for the peatland restoration will be to:

1. Reduce bare peat areas at cutting and erosion faces;
2. High overall vegetation cover;
3. Increase in the number of bog-mosses, particularly at the original bog surface;
4. Increase in the species richness of blanket bog species; and
5. Increase in wetness of the blanket bog, e.g. an increase in bog pools.

Current situation – Skaw Paet Hoose

The indictive area identified as Skaw Paet Hoose in Figure 2 is ca. 28.6ha in size. It is situated on the north slope of the Ward of Norwick, above the Burn of Skaw has been historically and extensively cut for peat. The historical peat cuttings were between ca.1m and 2m in height. There was little evidence of recent peat cuttings, and, as at Loomer Shun, the low sheep levels had allowed wide-scale revegetation on the bases of historically cut surfaces. The tops of the peat cuttings were dry, and heather dominated, and there were many exposed bare peat areas on the faces of the cuttings. These cut faces continue to release carbon through wind and rain erosion and microbial decomposition, along with reducing drying out of the remnant adjacent blanket bog.

Photo 10: Peat cutting around the 'Paet hoose'

Baseline – Skaw Paet Hoose

A site visit and PCA was undertaken at Skaw Paet Hoose in February 2022.

Figure 4 provides an indicative PCA map (based on a site visit and aerial photos). All of the peatland was classified as Modified and Drained, largely through peat cutting but also through some erosion features. The peat cuttings faces and erosion feature faces were considered to be actively eroding in most instances, although some exceptions are noted in the Target Notes (Table 2).

The total length of peat cuttings at Skaw Paet Hoose (based on aerial photos) was estimated to be ca. 3.7km[2].

The total length of erosion features at Skaw Paet Hoose (based on aerial photos) was estimated to be ca. 1.0km.

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[2] Note that these metrics and locations shown in Figure 4 are based on aerial images, viewed between 1:2,000 and 1:4,000 and have not been fully ground truthed. It is possible some 'peat cuttings' are actually 'erosion features' and visa versa. Lengths are estimates only.

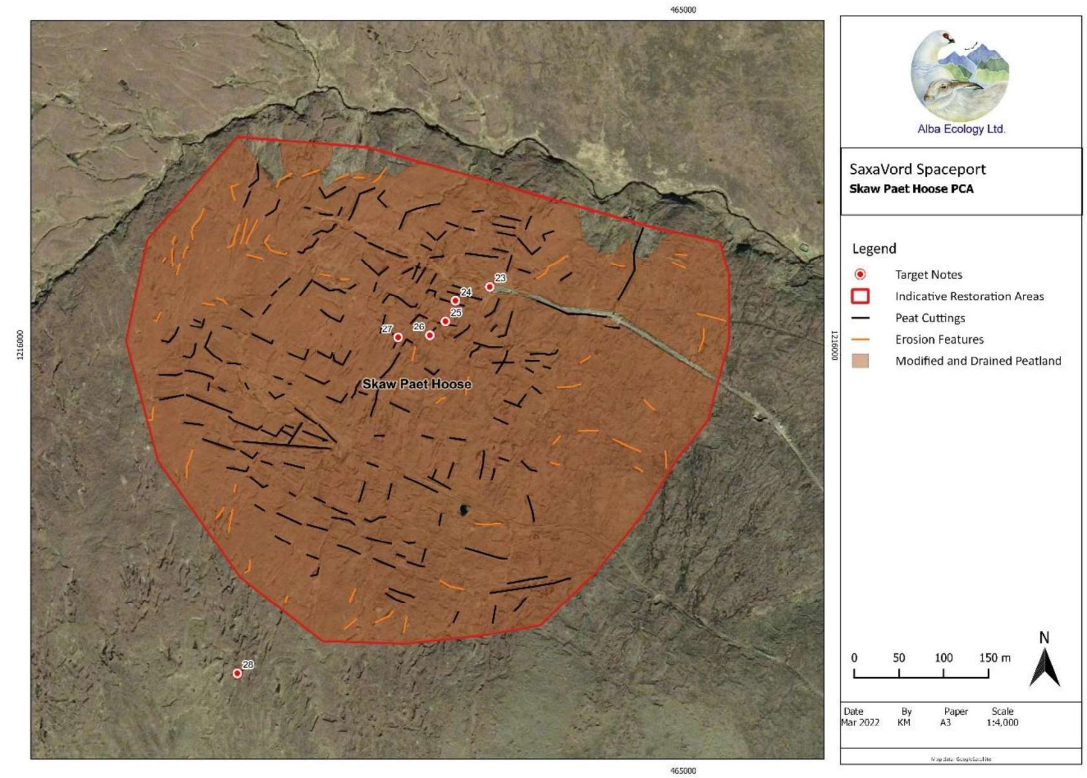

Figure 4: PCA and Target Note locations for Skaw Paet Hoose

The habitats were similar to those at Loomer Shun with a similar array of species present and the type of habitat dependent on the impact of peat cuttings. There was modified bog at the original bog surface which was usually dry particularly at the edges of peat cuttings. Heather, crowberry, common cottongrass, hare's-tail cottongrass, red bog-moss and glittering wood moss were the most common species.

The modified bog that had revegetated at the base of the cut surface where the remaining peat was >0.5m was generally damper underfoot than the original bog surface vegetation with occasional bog pools. There were patches of bare peat at the base of some erosion features.

Wet heath, dominated by heather and common cottongrass was present where vegetation had formed at the base of the cut surface where the peaty soils were <0.5m.

Unlike at Loomer Shun, some of the peat cuttings at Skaw Paet Hoose had collapsed over and fully revegetated, leaving little sign of the cutting except a raised profile. This demonstrates the sort of reprofiling that is anticipated and shows that revegetation is not only possible but is happening naturally in some areas, albeit at a slow rate of change. It is unclear how long this process has taken to naturally occur, but the peat cuttings in some places appear to be very old.

Table 2 provides details of the baseline through a series of Target Notes of the peatland habitats at the Paet Hoose. The Locations of the Target Notes are shown in Figure 4.

TG	Grid	Note	Photo
23	HP 64783 16065	Historic peat cutting. There was generally revegetation on the cut surface and on some cut edges. Suitable for reprofiling to connect the peat, re-wet the original bog surface and to form hydrological connectivity.	 
24	HP 64745 16050	Example of a historic peat cutting. It was ca. 1m high, with dry, heather dominated vegetation sloping over the edge. There was evidence of continued erosion from undercutting. The cut surface was well vegetated with common cottongrass and heather, forming a wet heath vegetation over ca. 0.5m of peaty soils.	
25	HP 64733 16027	Another example of a historic peat cutting. It was ca. 1.5m high. There were some patches of bare peat along the base of the cutting face. These were ca. 2m x 2m in size and were actively eroding. The cut surface had blanket bog vegetation over deep peat with occasional pools and patches of bog-mosses present.	

TG	Grid	Note	Photo
26	HP 64716 16011	This historic peat cutting was fully revegetated with areas of acid grassland and dry heath.	
27	HP 64680 16008	A more recent peat cutting. It was ca. 1.5m high and 20m long with evidence of active erosion and drying influences seen on the top.	
28	HP 64501 15633	A view of the area around Skaw Paet Hoose.	

Table 2: Target Notes for Skaw Paet Hoose

Delivery – Skaw Paet Hoose

There is suitability at Skaw Paet Hoose for careful and sensitive peatland restoration of the historic peat cuttings. Re-using peat extracted from the construction of the SaxaVord Spaceport is not anticipated as access is along an un-made track, unsuitable for taking large loads of peat along, but suitable for driving Argo cats and diggers on caterpillar tracks for the purpose of restoration.

Reprofiling would be undertaken as described for Loomer Shun and detailed in Appendix 1. The reprofiling would halt the current erosion on bare peat faces through wind and rain erosion; halt the bare peat faces losing mass through microbial decomposition; and reduce drying out of the remnant adjacent blanket bog. This will stop areas of Skaw Paet Hoose from being a carbon source. Furthermore, reprofiling the peat cuttings will wet-up and hydrologically link the existing bog vegetation, which is currently fragmented, and allow a more natural surface pattern and hydrology to develop. In turn, this will benefit the species that rely on wet bog vegetation such as craneflies and other insects, which further benefit associated bird species. This hydrologically linked wet bog will likely deliver additional carbon sequestration as the bog-mosses and bog vegetation form peat over a wider area, locking carbon into the peatland habitat. Hence, the Skaw Paet Hoose area would be transformed from being a source of carbon, to potentially an area with widespread carbon sequestration (i.e. a carbon sink).

Photo 11: A peat cutting at Skaw Paet Hoose suitable for reprofiling

The crofters (who we understand hold the peat cutting rights to this area) have agreed to a permanent cessation of peat cutting at Skaw Paet Hoose. This secures the long-term effectiveness of restoring the peat and blanket bog in this currently degraded area.

Similar to Loomer Shun, Skaw Paet Hoose has a low level of sheep grazing which is evidenced in the revegetation of the degraded bog habitat. Securing an agreement not to increase sheep levels would be beneficial.

Careful consideration of the timing of this work will be needed to avoid breeding bird disturbance and to prevent further erosion from the wind exposure. Works for peatland restoration at Skaw Paet Hoose are not scheduled until at least 2023/2024 and would be completed outside the bird breeding season.

Peatland restoration work at Skaw Paet Hoose will be undertaken under the supervision of an appropriately trained ecologist.

A baseline monitoring survey measuring species composition, vegetation height, peat depth and areas of bare peat will be undertaken prior to the peatland restoration beginning at a range of monitoring sites within Skaw Paet Hoose. The changes to the vegetation/peat will then be monitored at regular intervals, using standardised systematic methods.

The specific objective for peatland restoration and Skaw Paet Hoose will be to:

1. Reduce bare peat areas at peat cuttings;
2. High overall vegetation cover;
3. Increase in the number of bog-mosses, particularly at the original bog surface;
4. Increase in the species richness of blanket bog species; and
5. Increase in wetness of the blanket bog, e.g. an increase in bog pools.

Current situation – Ritten Hamar

Ritten Hamar, as identified in Figure 2, is an area of blanket bog in the very north of Unst and is ca. 14.3ha in size. It is characterised by numerous small lochans and widespread erosion features. Erosion is likely to have been due to a combination of sheep grazing and the extreme exposure to wind and rain erosion in the very exposed location. The erosion was active and noticeable. For example, in some areas the drier surface vegetation had been lifted and folded over in the wind (e.g. Photo 13).

Photo 12: Erosion features at Ritten Hamar

Photo 13: Surface vegetation lifted and folded over in the wind, exposing bare peat.

Baseline – Ritten Hamar

A site visit and PCA was conducted at Ritten Hamar in February 2022.

Figure 5 provides an indicative PCA map (based on a site visit and aerial photos). All of the peatland was classified as Modified and Drained. At Ritten Hamar the drainage was from erosion features rather than peat cutting. Active erosion was present along most the erosion features, which reached up to 3m in height. These had bare peat, exposed on the faces and exposed along the base of the erosion features.

The total length of erosion features at Ritten Hamar (based on aerial photos) was estimated to be ca. 3.6km[3].

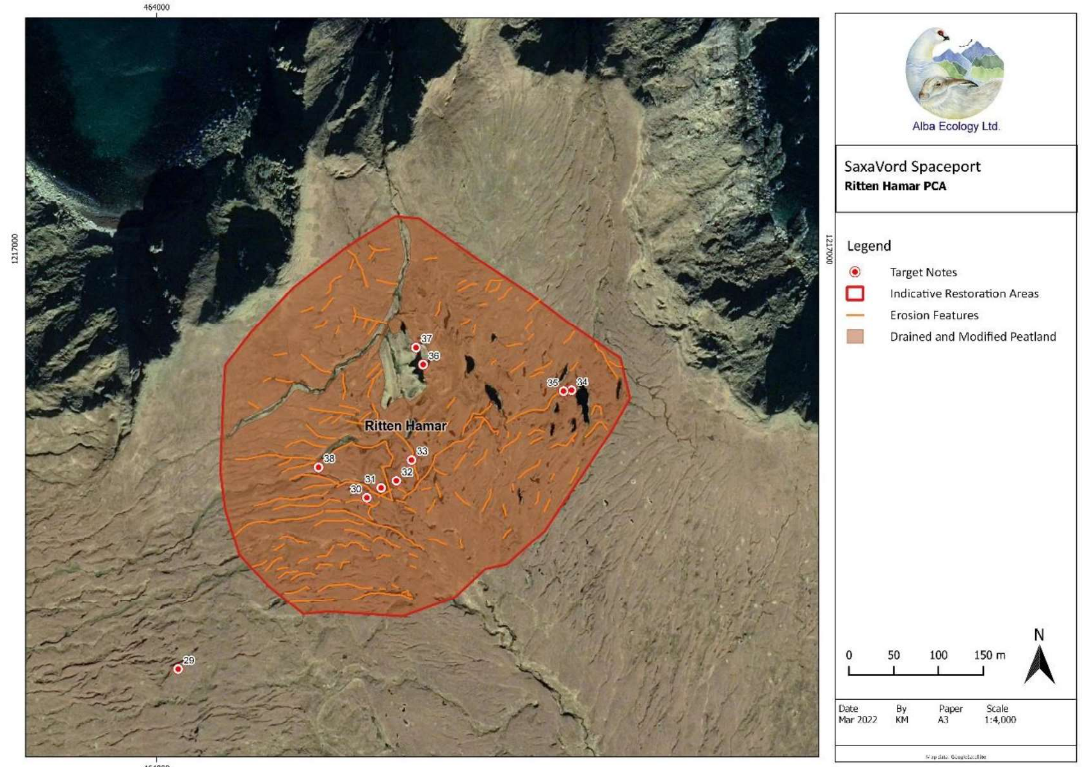

Figure 5: PCA and Target Note locations for Ritten Hamar

The vegetation across the wider area seen whilst walking to Ritten Hamar, where the bog was more intact, was blanket bog with heather, common cottongrass, crowberry, and a little hare's-tail cottongrass being the most common plants and making up the bulk of the vegetation. Mosses most frequently encountered were red bog-moss and glittering wood-moss. Heather was more common on drying edges of the erosion features. Around the numerous bog pool bog-mosses were more common and the ground was noticeably wetter.

Table 3 provides details of the baseline through a series of Target Notes of the peatland habitats at the Ritten Hamar. The locations of the Target Notes are shown in Figure 5.

[3] Note that these metrics and locations shown in Figure 5 are based on aerial images, viewed between 1:2,000 and 1:4,000 and have not been fully ground truthed. It is possible some 'erosion features' are actually other features in the landscape. Lengths are estimates only.

TG	Grid	Note	Photo
29	HP 64024 16530	View of Ritten Hamar. Erosion features evident from a distance. These were not from peat cutting but were likely formed from a combination of sheep grazing and climatic impacts. The surround blanket bog was in reasonable condition, with old features revegetating in places.	
30	HP 64235 16722	Erosion feature was ca. 1.5m high and 5m wide. It had a bare peat face and base which was actively eroding. It was very exposed and on a fairly shallow gradient. Therefore, it is considered that reprofiling and blocking this erosion feature would be possible using only peat from Ritten Hamar.	
31	HP 64251 16733	The erosion gully at this location was ca. 3m high and actively eroding. It was suitable for reprofiling. It was on a shallow gradient and may require blocked, but peat may be sufficient. There was a small pool at the base of this erosion feature. It was on shallow soil (ca. 0.3m), but with bog mosses present.	 
32	HP 64268 16741	Erosion gully going on a slightly steeper gradient. Some rocks may be required to block this gully. The erosion features were ca.1.2m high and would be suitable for reprofiling.	

TG	Grid	Note	Photo
33	HP 64285 16764	Illustrative photos from Ritten Hamar. The erosion features were ca. 1.2m high. Photos show the views from the east, south then west.	  
34	HP 64464 16842	An erosion gully suitable for blocking and reprofiling. It was at a shallow gradient so peat blocking may be sufficient.	
35	HP 64455 16841	There were also some small erosion features. This one was ca. 0.5m high.	

TG	Grid	Note	Photo
36	HP 64298 16871	Example of surface vegetation lifted and folded over in the wind, exposing bare peat.	
37	HP 64290 16890	Another example of surface vegetation lifted and folded over in the wind, exposing bare peat.	
38	HP 64181 16756	The vegetation across this area was made up of heather, common cottongrass, crowberry, and a little hare's-tail cottongrass. Snow cover prevented a clear view of the moss layer although there appeared to be a red bog-moss and glittering wood-moss component. The vegetation was generally short and open. There was an erosion feature nearby which was ca. 1m high and 3m wide. There was some bare peat exposed to mineral soil at the base.	  

Table 3: Target Notes for Ritten Hamar

Delivery – Ritten Hamar

Peatland restoration is recommended for Ritten Hamar. The erosion features should be restored through reprofiling and where appropriate gully blocking. Peatland restoration is often most effective if it is concentrated within a catchment area or hydrologically linked area. Ritten Hamar is ideal because it is at a watershed location and so the restoration work would support not only the bog habitat but also the associated lochans.

Erosion gullies could be blocked or re-profiled following best practice guidelines (e.g. Appendix 1). The exact location and number of dams required will necessarily be determined on the ground by the contractors. Blocking the gullies will be dependent on the size and the slope of the gully or erosion feature. Small gullies on shallow gradients may be able to be blocked with peat dams from adjacent areas in Ritten Hamar. However, as some of the haggs and gullies were large, stone dams may be required in some circumstance to ensure that water would be dammed and to prevent further erosion (see Appendix 1 for more details and best practice guidelines). Hagg reprofiling would be suitable for all the haggs >0.5m. A form of hagg reprofiling, called cross tracking, may be suitable for haggs and erosion features <0.5m.

The peatland restoration will deliver a series of benefits to the Ritten Hamar area, including halting the degradation, improving the hydrological connectivity and improving the area for wide bog species such as invertebrates and birds. The long-term outcome would be turning the areas from a carbon source to a carbon store and sink through carbon sequestration.

There is no direct road, or track access to Ritten Hamar. Therefore, bringing rocks (or other materials) to Ritten Hamar may be logistically challenging and restoration plans for this work element will need to consider how to do this work. The sea cliffs surrounding Ritten Hamar are ca. 80-100m high. Therefore, the beach at Wick of Skaw would be the closest location to bring the materials via the sea. Likewise, bringing materials by road, would likely to Skaw. Moving material from Skaw to Ritten Hamar may require either Argo cats or in some circumstances may may need to be lifted in by helicopter.

Similar to Loomer Shun and Skaw Paet Hoose, Ritten Hamar appeared to have a low level of sheep grazing. Securing an agreement not to increase sheep levels would be beneficial.

Careful consideration for the timing of this work will need to be taken into account to avoid breeding bird disturbance, but also to prevent further erosion from the wind exposure. The peatland restoration work at Ritten Hamar is not anticipated to begin until 2024/2025 and will take place outwith the bird breeding season.

Peatland restoration work at Ritten Hamar will be undertaken under the supervision of an appropriately trained ecologist.

A baseline monitoring survey measuring species composition, vegetation height, peat depth and areas of bare peat will be undertaken prior to the peatland restoration beginning at a range of monitoring sites within Ritten Hamar. The changes to the vegetation/peat will then be monitored at regular intervals, using standardised systematic methods.

The specific objective for the peatland restoration at Ritten Hamar will be to:

1. Reduce bare peat areas erosion features;

2. High overall vegetation cover;
3. Increase in the number of bog-mosses;
4. Increase in the species richness of blanket bog species; and
5. Increase in wetness of the blanket bog, e.g. an increase in bog pools.

Objective 3. Create native riparian broadleaf tree/scrub cover

Current situation

Given historical clearance of all native woodland on Unst, there is now little woodland cover anywhere on the island outside of private residential gardens. Such cover, as it exists, is highly fragmented and offers very limited opportunities to benefit resident and migrant bird species.

Delivery

The Burn of Skaw lies within is a sheltered west to east facing valley. Many of the bends are well sheltered and contained old planticrubs (small circular dry-stone enclosures formerly used for growing crops in) which provided soil, shelter from the sheep and also, to some extent wind. There is no woodland this far north in Unst and the creation of several small, but discrete planted up areas of native broadleaves on the sheltered bends of the Burn of Skaw would create Britain’s most northerly woodland, albeit mainly scrub and localised in nature.

Such woodland/scrub expansion will likely benefit a range of songbird species, which should occur in greater numbers/densities and which also form the main basis of merlin prey, which although not breeding, do forage in this area.

Figure 6 indicates the area intended for planting as part of the HMP, which totals ca. 8ha. Table 4 gives the baseline conditions for this area.

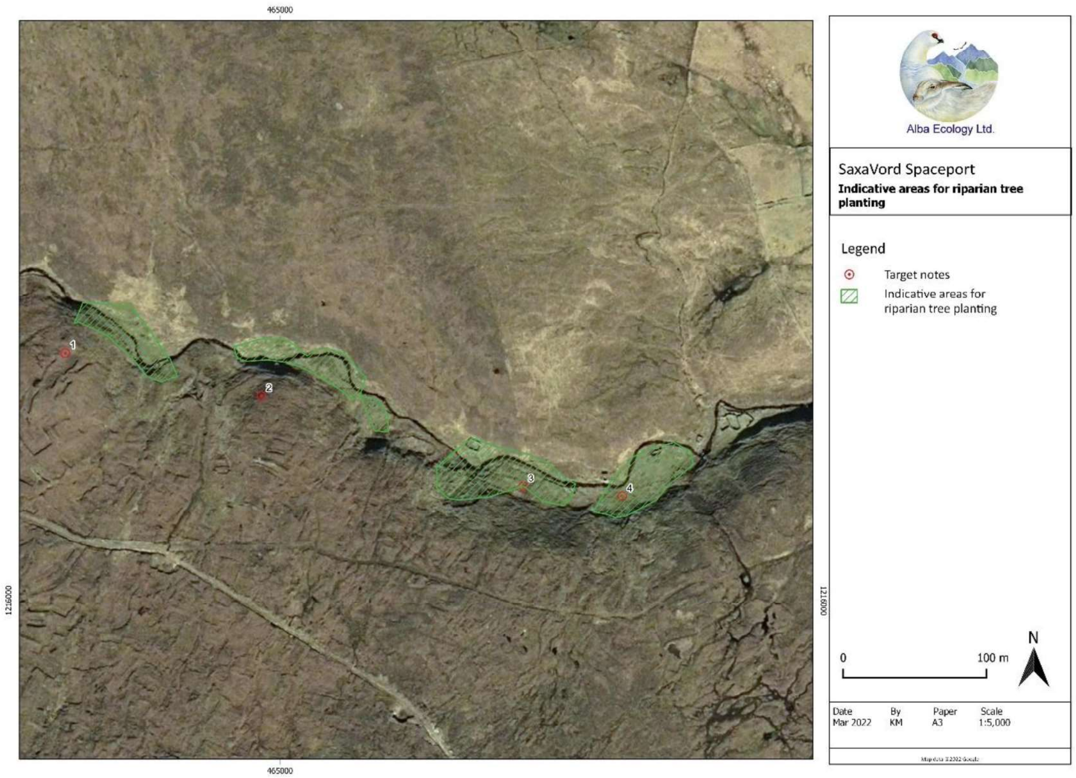

Figure 6: The indicative area for tree riparian tree planting along the Burn of Skaw

TG	Grid	Note	Photo
1	HP 64850 16173	Sheltered valley with suitable areas for planting riparian species along the site of the Burn of Skaw. The existing riparian vegetation was sheep grazed acid grassland.	
2	HP 64987 16143	The flat areas, beside the Burn of Skaw, were relatively sheltered from the prevailing wind.	

TG	Grid	Note	Photo
3	HP 65170 16080	This fenced area with a broken sheiling was considered ideal for planting. It was primarily acid grassland with bent grasses, mat grass, heather, heath bedstraw and tormentil. There were patches of heather and soft rush. The fenced area was ca. 10m wide and 20m long.	
4	HP 65239 16073	This small flat area alongside the Burn of Skaw was considered ideal for riparian tree planting. It was made up of acid grassland with tormentil, bent grasses and mat grass with some soft rush also present. It was c. 10m x 10m is size.	

Table 4: The target notes for the areas identified for riparian tree planting, Burn of Skaw.

The location of the native riparian planting along the Burn of Skaw is on land on which SaxaVord Spaceport have a long-term management agreement on and so the work will be guaranteed to be taken forward.

The riparian corridor along the Burn of Skaw was heavily grazed by sheep and native broadleaved scrub woodland would not survive without effective stock-proof fencing. There will need to be gaps between planted areas to facilitate sheep access across the valley. The indicative areas for planting and fencing are shown in Figure 6. In addition to providing habitat for species which would form part of merlin diet, this action will also allow heather to increase in height which could provide cover and suitable habitat for nesting.

Following discussions in 2020 with the Shetland Amenity Trust on planting trees in Shetland, downy birch, with a mix of other species in appropriate locations including alder, hazel, grey willow, rowan and aspen will be planted in the areas indicated in Figure 6. It is considered that the most appropriate species for planting here are likely to be downy birch, grey willow and alder. The Shetland Amenity Trust will be commissioned to grow and plant trees within this area during the appropriate time of year in 2023-2024.

Objective 4. Coastal grassland habitat management

Current situation

The coastal grassland habitat on the cliff tops of Lamba Ness and The Garths meets Annex 1 habitat and Scottish Biodiversity List (SBL) descriptions and so is of conservation interest (e.g. Photo 14). The coastal grasslands were dominated by red fescue with a variety of maritime species such as thrift, plantains and a variety of wild flowers at varying abundances (e.g. Photo 15).

These types of coastal grasslands are dependent on low-intensity, traditional farming (PlantLife, 2014). Low-intensity sheep grazing, where animals are removed in late spring and returned in autumn, is extremely important to maintain the community and species richness. Abandoning these traditional management practices is considered the key threat to coastal grasslands across the UK (PlantLife, 2014). Without seasonal grazing, the coastal grassland habitats tend to become less species rich as micro habitats close up. This means fewer opportunities for the rarer species to seed or spread (PlantLife, 2014).

Photo 14. Example of coastal grassland at Lamba Ness

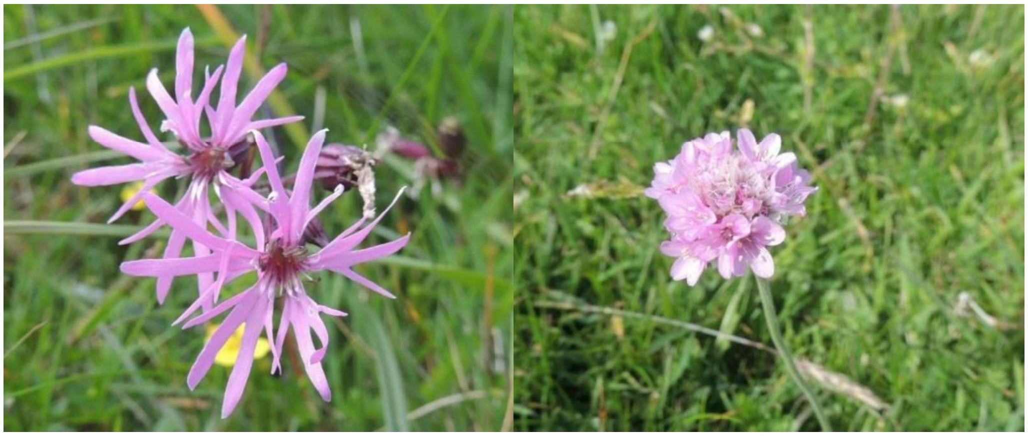

Photo 15. Wildflowers in the coastal grassland - ragged robin and thrift

Delivery

With careful sheep management the coastal grassland habitats can be maintained and enhanced. It is known that "*Traditional grazing regimes use sheep to maximise flowering success. This means grazing in winter with short exclusions during the summer to allow plants to flower and set seed (roughly May - September). Heavy grazing in the autumn is important as it removes the year's crop of grasses and herbs. Ideally this should take place from September when the grasses and herbs are still nutritious. Lighter grazing until April produces the ideal conditions for many plants to survive in healthy populations*" (PlantLife, 2014).

Sheep grazing on Lamba Ness will continue and will follow traditional management regimes. The number of sheep and timing of sheep grazing will follow traditional grazing management regimes and be agreed in consultation interested parties (e.g. NatureScot, SIC).

An agreement will been made with the crofters for a suitable grazing regime on Lamba Ness between mid-September and April once the construction of SaxaVord Spaceport has been delivered.

Monitoring

In order to monitor progress of the HMP, it will be necessary to regularly monitor the effectiveness and success of the restoration measures implemented. To do this an initial assessment of baseline conditions would be required (establishing the baseline, including photos), followed by regular post restoration monitoring (including photos)

Table 5 displays the type of monitoring that should be considered for each restoration technique, before and after implementation.

The most commonly used methods for the pre and post restoration monitoring will be moorland breeding bird surveys, vegetation quadrat assessments and assessment of the planted trees.

Moorland breeding bird survey

The modified Brown and Shepherd (1993) Moorland Breeding Bird survey is the standard survey technique for moorland/upland breeding birds (Gilbert *et al*., 1998). The Brown and Shepherd methodology is based on a constant search method involving spending 25 minutes every 500m × 500m quadrant. This equates to spending 100 minutes for every km^2. The restoration area would be split into a number of 500m x 500m quadrants. Each quadrant would be walked to ensure that all parts were approached to within 100m. At regular intervals, the surveyor will pause, scanned the area for species and listened out for calls and songs. All registrations will be marked on a 1:25,000 scale map using British Trust for Ornithology symbols with a note of the species activity. The main habitat is broadly defined as open moorland so this survey technique was used across all parts of the Study Area.

Vegetation quadrat assessment

Quadrat data will be taken in a standard 2×2m quadrat. All higher plants and common mosses will be identified and their percentage cover assessed. The height of heather and bog mosses will be assessed in each quadrat with a tape measure, six times per quadrat. Quadrat data will provide details on the NVC communities present and any changes in the NVC community. Height data will provide a measure of the structural changes with e.g. reduced grazing pressure.

Tree assessment

Visual inspection for tree/scrub mortality and general will be undertaken on a regular bases. Any dead or dying trees will be replaced. Replanting. The integrity and effectiveness fencing will also be assessed regularly.

Objective	Type of monitoring	Method	Why	Frequency (Years)
Objective 1. Sea-watching hide	Hide maintenance	Vigilance by local community users	To ensure repairs are undertaken promptly	Ongoing
Objective 2. Blanket bog/peatland habitat restoration	Birds	Breeding Bird surveys	To demonstrate whole ecosystem change	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.
	Vegetation	The percentage cover of bog-moss and indicator plant species, bare peat and vegetation height with the use of quadrats, including within control areas not under favourable management	To demonstrate any changes in species composition and structure	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.
Objective 3. Native broadleaf woodland	Vegetation	Visual inspection for tree/scrub mortality (replanting if necessary) and measures of tree height	Ensuring that the planted trees are growing successfully	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.
	Monitoring of exclosures	Visual inspection of integrity of fences and exclosures	To ensure tree/scrub growth takes place	2-3 times annually
Objective 4. Coastal grassland habitat management	Vegetation	Assessment of species richness through quadrats	To demonstrate successful maintenance and enhancement of coastal grassland habitats.	Pre restoration, 1, 2, 3, 5, 10, 15, 20, 25 and 30.

Table 5: The type of ecological/ornithological monitoring recommended for the approved HMP

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Appendix 6.1 SaxaVord Spaceport Natural Heritage Desk Study

Natural Heritage Information Desk Study for Shetland Space Centre

Alba Ecology Ltd.

August 2020

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Introduction

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the 'Shetland Space Centre' (SSC). As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a natural heritage desk study to identify biological records within the potential zones of influence and to locate conservation designated sites within a 10km radius of the Site.

The SSC Proposed Development comprises of work in three discrete areas: (i) a Proposed Launch Site at Lamba Ness, (ii) a Proposed Launch and Range Control Centre Site, and (iii) a Proposed New Section of Access Road at Northdale. This report considers all three of these areas.

The Search Area for the Desk Study comprised of the Proposed Development plus a 1km buffer. The zone of influence from Proposed Launch Site was considered potentially greater than this for certain taxa, therefore a 4km buffer was considered a suitable Search Area for birds and mammal species. A location map can be seen in Appendix 7.1 Drawing 1[1] with the 1km Search Area and the additional 4km bird and mammal Search Area shown.

A search of biological records was conducted in 2020 using data obtained from the Shetland Biological Records Centre, from the NatureScot (formerly Scottish Natural Heritage; SNH) SiteLink Website and other relevant web-based sources such as the Shetland Island Council web pages, designated site citations and the National Biodiversity Network (NBN) Atlas.

A previous desk study was written in 2017 (to help inform potential surveys) for this proposal based on a wider search area as the design layout had not be finalised at that time. The previous desk study is superseded by this more up to date report and associated spreadsheets.

This desk study aims to identify records of species and habitats of conservation importance within the Search Area, using the relevant potential zones of influence, and designated sites within 10km of the Site.

Study methods

The data search for this desk study follows the Chartered Institute of Ecology and Environmental Management (CIEEM) best practice guidelines (CIEEM, 2016; CIEEM, 2017). The background data aims to provide the following information:

- Designated site information;
- Existing records of protected/priority/notable species for the Site;
- Existing records of protected/priority/notable species for the surrounding area; and

[1] Drawing 1 is provided within this report document, but a higher resolution version is provided separately as a PDF.

- Habitat information where available.

Designated site information

Sites with biological conservation designations located within 10km of the Application Boundary were identified using the NatureScot SiteLink Website (2020). These included Sites of Special Scientific Interest (SSSI), Special Areas of Conservation (SAC), Special Protection Areas (SPA), Marine Protection Areas (MPA) and Ramsar sites. The local nature conservation sites were identified using the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Existing species records for the Search Area

Species records were obtained by commissioning data searches from the local biological records centre, as per CIEEM best practice guidelines. The Shetland Biological Records Centre was commissioned to search for biological records within the Search Area. Provision of the data by the recorders is neutral and should not be regarded, either explicitly or implicitly, as approving or opposing any project informed by the data provided.

As with all desk studies, the data collected are only as good as the data supplied to the recording schemes. The recording schemes and recorders provide disclaimers in relation to the quality and quantity of the data they provide and these should be considered when examining the outputs of this desk study. No attempt has been made to verify these records. Common (vernacular) names are used where they have been provided by the recorder.

All biological records within the Search Area were searched for on the NBN Atlas. The CIEEM (2016) guidance stipulated avoiding the use of the NBN for commercial purposes due to constraints to the licence of the data. However, the Guidance notes that there is a "*general trend, supported by governments, towards Open Data to increase access to data for all stakeholders and the situation is likely to change significantly in the coming years"*. Due to the updated and explicit guidance on the use of the Open Data for commercial purposes on the NBN Atlas website, the CIEEM guidance is deviated from on this point, but it is considered to be in keeping with its aims and expectations.

All records for the Proposed Development plus a 1km buffer, were downloaded on the NBN Atlas website in August 2020. As per NBN Atlas guidance for commercial use, only the records which have an Open Data licence (coded CCO, CC-BY and OGL) have been considered and presented here. These data "*can be used for any purpose*" (NBN Atlas, 2020). Those data with a non-commercial licence (CC-BY-NC) were not included and were not inspected or considered. This is accordance with the NBN Atlas terms and conditions for commercial use (NBN Atlas, 2020).

It should be noted that the Data Provider, Original Recorder [where identified], and the NBN Trust bear no responsibility for any further analysis or interpretation of that material, data and/or information.

Relevant literature sources, including Living Shetland LBAP documents, nearby designated site citations and relevant literature sources such as Rare Plants of Shetland (Scott, *et al.* 2002) were considered for species that could potentially be present within the Search Area.

All records, from all sources, were compared against the Scottish Biodiversity List and the Local Biodiversity Action Plan (LBAP) list of important species.

Existing habitat records for the Search Area and surrounding area

Relevant sources, such as the Living Shetland LBAP documents, the nearby designated site citation and relevant literature sources were considered in relation to the habitats likely to be present within and around the Search Area.

Results

Designated site information

A total of 10 designated sites with ecological qualifying features within a 10km radius of the Proposed Development have been identified (Table 1). The closest was Norwick Meadows SSSI, which is between the Proposed New Section of Access Road at Northdale and the Proposed Launch and Range Control Centre Site. There are a number of Local Nature Conservation Sites on Unst. These are listed in Table 2.

Designated site	**Designation type**	**Area (ha)**	**Distance (km) and direction from Proposed Development**	**Biological Qualifying features**
Hermaness, Saxa Vord and Villa Field	SPA	6,832ha	1.5km, West	Breeding birds: • Fulmar (*Fulmarus glacialis*) • Gannet (*Morus bassanus*) • Great skua (*Stercorarius skua*) • Guillemot (*Uria aalge*) • Kittiwake (*Rissa tridactyla*) • Puffin (*Fratercula arctica*) • Red-throated diver (*Gavia stellata*) • Shag (*Phalacrocorax aristotelis*) Breeding bird assemblages
Keen of Hamar	SAC	40ha	3.2km, South	Upland habitats: • Base rich scree • Dry heath Grasslands on soils rich in heavy metals
Keen of Hamar	SSSI	50ha	3.2km, South	Calaminarian grassland and serpentine heath

Designated site	Designation type	Area (ha)	Distance (km) and direction from Proposed Development	Biological Qualifying features
				Vascular plant assemblages
Hill of Colvadale and Sobul	SSSI	809ha	5.7km, South	Arctic sandwort (*Arenaria norvegica*) Breeding birds: • Arctic skua (*Stercorarius parasiticus*) • Whimbrel (*Numenius phaeopus*) Breeding bird assemblages Calaminarian grassland and serpentine heath
Valla Field	SSSI	629ha	4.2km, Southwest	Breeding birds: • Great skua • Red-throated diver
Crussa Field and Heogs	SSSI	469ha	2.0km, South	Breeding birds: • Arctic skua • Whimbrel Breeding bird assemblages Vascular plant assemblages Calaminarian grassland and serpentine heath
Hermaness	SSSI	978ha	2.9km, West	Breeding birds: • Fulmar • Gannet • Great skua • Guillemot • Puffin Breeding seabird colony
Saxa Vord	SSSI	56ha	2.3km, West	Breeding birds: • Fulmar • Guillemot Breeding seabird colony
Norwick Meadows	SSSI	25ha	0.1km, South and North	Sand dune habitats Valley fen wetlands
Fetlar to Haroldswick	MPA	216000ha	0.9km, South	Aggregation of breeding birds: • Black guillemot (*Cepphus grylle*) Horse mussel beds Circalittoral sand and coarse sediment communities Kelp and seaweed communities on sublittoral sediment

Table 1: Biological Designated Sites within 10km of the Site.

Local Conservation Sites on Unst	Primary Interest	Justification for Local Conservation Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site. This is the only site in Shetland where harebell (*Campanula rotundifolia*) may still occur.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Arctic sandwort and northern rock cress (*Arabis petraea*)

Table 2: The Local Nature Conservation Sites on Unst with their features of primary interest and the justification as specified in the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Existing species records for the Search Area

Shetland Biological Records Centre data

The Shetland Biological Records Centre searched for all biological records within the Search Area. Due to the large number of data the search on birds was limited to post 2000 records and the search on all other taxa was limited to post 1990 records. The search provided a total of 4,392 bird records with a total of 105 species and a further 2,719 species records for other taxa, including 782 different species. Many of these records were beyond the 1km buffer of the Study. The full list of species and SBL species can be seen in Annex 1: Desk Study Data Sheet - Shetland Biological Records Centre Search.

Table 3 provides a summary of data by taxonomic groups.

Order/Class/Group	Notes (includes)	No' of species recorded
Amphibian		1 Species
Arachnids	Spiders & mites	58 Species
Birds		105 Species
Coleoptera	Beetles	50 Species
Diptera	Two-winged or true flies	36 Species
Hemiptera	True bugs	1 Species
Hymenoptera	Bees, wasps, ants & sawflies	5 Species
Lepidoptera	Butterflies & moths	132 Species
Lichen		130 Species
Mammals		17 Species
Mosses and liverworts		76 Species
Vascular plants		276 Species

Table 3: Summary of biological records provided by Shetland Biological Records Centre (search conducted in 2020).

A total of 56 species recorded from the Shetland Biological Records Centre are on the Scottish Biodiversity List (Annex 1). These include two mammals, 13 insects, five plants, six lichens and 30 birds (Annex 1; Table 4). The list of species recorded as part of the Shetland Biological Records Centre data search on the SBL can be seen in Annex 1.

The two terrestrial mammal species recorded within the Search Area from the Shetland Biological Records Centre which are on the SBL were otter (*Lutra lutra*) and Nathusius's pipistrelle (*Pipistrellus nathusii*). Nathusius's pipistrelle is a long-distance migrant and most UK records are for solitary individuals. Fewer than ten maternity colonies have been discovered in Britain and all from the east coast; Kent, Norfolk and Northumberland (Crawley *et al.,* 2020). Consequently, this Unst record is considered likely to be from a continental migrant as bats are not known to breed in Shetland. Otters have been recorded around Norwick on numerous occasions. Appendix 7.3 Otter Survey Report provides detail of the otter surveys conducted as part of the EIAR. Marine mammals are considered in EIAR Chapter 13: Marine and Transboundary Effects. Birds are considered in EIAR Chapter 6: Ornithology.

The insects that are on the SBL and are recorded as part of the Shetland Biological Records Centre data search are all within the "*watching brief only"* category of the SBL. Four species were recorded within the vicinity of the Proposed Development. Haworth's minor (*Celaena haworthii*) is "*mainly a moorland species, occurring most commonly in northern England, Wales and Scotland… Cotton-grass (*Eriphorium *spp.) is the main foodplant, the larvae feeding internally on the stems*" (UK Moths, 2020). Autumnal rustic (*Eugnorisma glareosa*) inhabits "*woodland fringes, moorland and sandy or chalky soils, it is widely distributed, though not always common, throughout Britain. The adults fly in August and September, and the caterpillars are polyphagous, living on a wide variety of plants and grasses*" (UK Moths, 2020). Ghost moth (*Hepialus humuli*) is considered a "*common species over much of Britain… The adults fly during June and July. The larvae feed underground on the roots of grasses and small plants* (UK Moths, 2020). Red carpet (*Xanthorhoe decoloraria*) is "*a locally common species in northern Britain, occurring from Shropshire and Staffordshire northwards, into Scotland, where a local subspecies* hethlandica *occurs on the Shetland Isles… The favoured habitat is rocky moorland,* *where the larvae feed on lady's mantle Alchemilla spp., possibly also on other low plants* (UK Moths, 2020).

The lichens that are on the SBL and were recorded as part of the Shetland Biological Records Centre data search are all within the "*watching brief only*" category of the SBL. Although three of the lichen species have EU obligations and four of the lichen species are considered rare in Scotland (SBL, 2013, Annex 1). Four of the lichen species were recorded on Lamba Ness. These include two that have international obligations and three that are considered nationally rare (SBL, 2013). The lichen *Caloplaca britannica* "*is found on coastal rocks, in the spray zone and is undoubtedly under-recorded*" (Images of British Lichens, 2013). In Shetland it is known to be located in "*sheltered crevices in landward-facing rock face*" (Dalby and Dalby, 2005). The lichen *Leptogium britannicum* is found on coastal rocks (Images of British Lichens, 2013). In Shetland it is known to be located amongst mosses in salt marshes and on cliffs (Dalby and Dalby, 2005). The lichen *Opegrapha areniseda* is found on "*slightly acid or neutral soft rocks near the seashore (schists) and mainly on old walls, notably of chapels*" (Maritime Lichens, 2020). No information was found on the UK habitat requirements of the lichen *Thelenella muscorum var. octospora*.

Of the five vascular plants on the SBL, chicory (*Cichorium intybus*) and wild pansy (*Viola tricolor*) are in the "*conservation action needed*" category and field gentian (*Gentianella campestris*) and frog orchid (*Coeloglossum viride*) are considered to be vulnerable in Scotland. All five species were recorded >700m away from the Proposed Development.

Species name	Common name	Number of records	Closest record to Proposed Development
Lutra lutra	Otter	5	>700m, Norwick
Pipistrellus nathusii	Nathusius's pipistrelle	5	>600m, Norwick
Bombus (Thoracombus) muscorum	Moss carder-bee	3	150m, Houlanbrindy
Apamea remissa	Dusky brocade	3	150m, Houlanbrindy
Arctia caja	Garden tiger	1	>1km, SW of Saxa Vord
Celaena haworthii	**Haworth's minor**	**6**	**1 in Saxa Vord, 1 150m, Houlanbrindy**
Celaena leucostigma	Crescent	1	150m, Houlanbrindy
Dasypolia templi	Brindled ochre	6	150m, Houlanbrindy
Diarsia rubi	Small square-spot	3	150m, Houlanbrindy
Entephria caesiata	Grey mountain carpet	2	>500m, Norwick
Eugnorisma glareosa	**Autumnal rustic**	**1**	**Within Saxa Vord**
Hepialus humuli	**Ghost moth**	**5**	**Near Northdale**
Hydraecia micacea	Rosy rustic	4	>600m, Norwick
Xanthorhoe decoloraria	**Red carpet**	**1**	**Within Saxa Vord**
Monocephalus castaneipes	Broad groove-head spider	2	>900m, Norwick
Cichorium intybus	Chicory	1	>700m, Millfield
Coeloglossum viride	Frog orchid	1	>1.2km, beyond Skaw
Gentianella campestris	Field gentian	1	>1km, beyond Skaw
Lathyrus japonicus	Sea pea	7	>700m, Norwick
Viola tricolor	Wild pansy	1	>950m, Ward of Norwick
Brigantiaea fuscolutea	A lichen	2	>1km, Hill of Cibberswick
Caloplaca britannica	**A lichen**	**1**	**Lamba Ness**
Leptogium britannicum	**A lichen**	**2**	**Lamba Ness**
Lobaria virens	Green satin lichen	1	>1km, Hill of Cibberswick
Opegrapha areniseda	**A lichen**	**1**	**Lamba Ness**
Thelenella muscorum var. octospora	**A lichen**	**1**	**Lamba Ness**

Table 4: Species from the Shetland Biological Records Centre data search, within the Search Area, which are listed on the SBL (except birds). Bold indicates close proximity to Proposed Development.

Additional information, courtesy of Paul Harvey of the Shetland Biological Records Centre, provides details of species in the data search which are considered to be rare, scarce, or threatened in Shetland (Harvey, *pers comm*, May 2020).

<u>*Bryophytes*</u>

- Lindberg's bog-moss (*Sphagnum lindbergii*) is considered Nationally Scarce and this is the only location known in Shetland. This species was recorded >2km northwest of the Proposed Launch Site on Saxa Vord hill (not the Saxa Vord Resort).
- Dwarf streak-moss (*Rhabdoweisa fugax*) is considered rare in Shetland on current knowledge. This was recorded >2km northwest of the Proposed Launch Site at Ritten Hamar.

Vascular plants

- Wilson's filmy-fern (*Hymenophyllum wilsonii*) is considered Near Threatened and is scarce in Shetland. This species was recorded >2km northwest of the Proposed Launch Site on Saxa Vord hill (not the Saxa Vord Resort).
- White sedge (*Carex curta*) is scarce in Shetland. This species was recorded along the Burn of Norwick, likely within the Norwick Meadows SSSI, approximately 330m from the Proposed Launch and Range Control Centre.
- Bog sedge (*Carex limosa*) is scarce in Shetland. This species was recorded along the Burn of Norwick, likely within the Norwick Meadows SSSI, approximately 330m from the Proposed Launch and Range Control Centre.
- Frog orchid (*Coeloglossum (Dactylorhiza) viride*) is considered Vulnerable nationally. This species was recorded >1km north of the Proposed Launch Site.
- Oysterplant (*Mertensia maritima*) is considered Near Threatened and Nationally Scarce and scarce in Shetland. This was recorded in Inner Skaw in July 2019 as well as some locations north of the Proposed Launch Site.
- Arctic sandwort is considered Vulnerable nationally and rare in Shetland. This species was recorded >1.5km south west of the Proposed Launch and Range Control Centre at Hill of Cibberwick.
- Sea kale (*Crambe maritima*) is rare in Shetland. This species was recorded ca. 850m north of the Proposed Launch Site.
- Northern rock-cress is considered Vulnerable nationally and Nationally Scarce and scarce in Shetland. This species was recorded >1.5km south west of the Proposed Launch and Range Control Centre near Hill of Cibberwick.
- Corn spurry (*Spergula arvensis*) considered as Vulnerable nationally. This species as recorded at Northdale, near the New Section of Access Road at Northdale and near the Proposed Launch and Range Control Centre.
- Sea pea (*Lathyrus japonica*) is now extinct at this site. This species was historically recorded at Norwick.
- Long-headed poppy (*Papaver dubium*) is scarce in Shetland. This species was recorded in Norwick cemetery.

Corn spurry and oysterplant are of most relevance as they have both been recorded near the Proposed Development. Corn spurry was recorded at Northdale and near the Proposed Launch and Range Control Centre. Oysterplant was recorded in Inner Skaw which is within the vicinity of the Proposed Launch Site.

NBN Atlas data

The NBN Atlas data search provided a total of 793 records for the Search Area from a variety of taxa and from freely available data sources. The total number of species was 531. Species which were already considered as part of the Shetland Biological Records Centre search were removed. This left 288 additional species for the Search Area. These are presented in Annex 2 Desk Study Data Sheet – NBN Atlas Search.

Table 5 provides a summary of the additional species found using the NBN Atlas (listed by taxonomic group).

Order/Class/Group	Notes (includes)	No' of species recorded
Actinopterygii	Fish	5
Algae		8
Annelida	Earthworm	1
Birds		8
Chromista		3
Coleoptera	Beetles	7
Diptera	Two-winged or true flies	5
Lichen and fungi		80
Mammal		2
Mollusca	Mussels	4
Mosses and liverworts		120
Neuroptera	Net-winged insects, e.g. lacewings	1
Plants		27
Plecoptera	Stoneflies	2
Sessilia	Barnacles	2
Trichoptera	Caddisflies	13

Table 5: Summary of biological records provided by the NBN Atlas (search conducted August 2020).

The full list of additional species is provided in the accompanying Annex 2.

A total of 10 species recorded from the NBN Atlas data search are on the SBL (Annex 2). These include three fish, five birds and two lichens (Annex 2; Table 6). The list of species recorded as part of the NBN Atlas data search on the SBL can be seen in Annex 2.

The three fish species are all of conservation importance, but as they are non-terrestrial species they are not considered further.

The two lichen species are both within the "*watching brief only*" category of the SBL. *Caloplaca dichroa* "*occurs on sunny, exposed limestone rocks*" (Dorset Nature, 2020) and was recorded at Haroldswick Methodist Church. Little information on habitat was found for the species *Gyalecta foveolaris* which was recorded within the 10km grid square on Unst in the 1960s.

Species name	Common name	Number of records	Closest record to Proposed Development
Anguilla anguilla	Eel	1	Sea
Salmo salar	Atlantic salmon	1	Sea
Salmo trutta	Sea/brown trout	1	Sea
Caloplaca dichroa	A lichen	1	Haroldswick - Methodist Church
Gyalecta foveolaris	A lichen	1	No details (record from 1960)

Table 6: Species listed in the NBN Atlas dataset from the Search Area which are on the SBL (except birds).

LBAPs – Species Action Plans

There are number of Species Action Plans, as part of the Living Shetland LBAP (SIC, 2020). These include:

- Arable Birds;
  - Twite (*Carduelis flavirostris*), house sparrow (*Passer domesticus*), skylark (*Alauda arvensis*), meadow pipit (*Anthus pratensis*), starling (*Sturnus vulgaris*), and rock dove (*Columba livia*) (Ellis, 2004).
- Arable Plants;
  - Knotgrass (*Polygonum aviculare*): restricted to Fair Isle.
  - Lesser trefoil (*Trifolium dubium*): always restricted to southernmost south Mainland where it was once well established, but not seen since 1982.
  - Henbit dead-nettle (*Lamium amplexicaule*): occurred occasionally in south Mainland, but last recorded in 1987.
  - Common cornsalad (*Valerianella locusta*): formerly found in two sandy arable areas at the north of Unst and southernmost south Mainland, but not seen since 1966.
  - Wood burdock (*Arctium nemorosum*): always restricted to southernmost South Mainland, with just 20 plants counted in 2000.
  - Long-headed poppy: formerly a widespread but scarce weed of arable ground, now restricted to a handful of locations, the majority of which are in the south Mainland.
  - Field pansy (*Viola arvensis*): formerly a regular arable weed in north Unst, north Yell and southern south Mainland, but only occasional sightings in south Mainland since 1997.
  - Slender parsley-piert (*Aphanes australis*): although always having a localised distribution it was last seen in 1982.
  - Sun spurge (*Euphorbia helioscopia*): formerly found on arable ground on Unst, Fetlar, Yell and the limestone of central Mainland, but since 1990 almost confined to the southern South Mainland.
  - Dove’s-foot crane’s-bill (*Geranium molle*): always a localised distribution but in recent years rarely seen and now restricted to North Yell, South Mainland and a holm off Vementry.
  - Red bartsia (*Odontites vernus*): formerly used to grow along the edges of cornfields but now restricted to sandy pastures at four sites in Shetland.
  - Corn marigold (*Chrysanthemum segetum*): once scattered amongst oats or potatoes in various parts of Shetland (Harvey, 2004).
- Arctic char (*Salvelinus alpinus*).
- Breeding Waders;
  - Oystercatcher (*Haematopus ostralegus*), ringed plover (*Charadrius hiaticula*), golden plover (*Pluvialis apricaria*), lapwing (*Vanellus vanellus*), dunlin (*Calidris alpina*), snipe (*Gallinago gallinago*), whimbrel (*Numenius phaeopus*), curlew (*Numenius arquata*), redshank (*Tringa totanus*), greenshank (*Tringa nebularia*) and common sandpiper (*Actitis hypoleucos*) (Ellis, 2004).

- Bumblebees (*Bombus spp*.).
- Eider (*Somateria mollissima*).
- Harbour porpoise (*Phocoena phocoena*).
- Hawkweeds (*Hieracium* spp.).
- Merlin (*Falco columbarius*).
- Oysterplant.
- Red-necked phalarope (*Phalaropus lobatus*).
- Red-throated diver.
- Skylark.

Only oysterplant, of the LBAP plant species, have recently been recorded in the Search Area. Many of the LBAP bird species are known to use the Proposed Development Area.

Existing habitat records for the Search Area and surrounding area

Few records of existing habitat surveys within the Search Area were located. The main two were;

- Norwick Meadows SSSI citation (NatureScot, 2020);
- A draft NVC survey of Norwick Meadows SSSI (Smedley and Uttley, 1994, provided by Johnathan Swale of SNH in June 2018); and
- Sand Dune Vegetation Survey of Scotland (Dargie, 1998), which included the sand dunes at Inner Skaw.

There were some additional, more general published resources for habitats in Shetland such as coastal grassland management guide and the Habitat Action Plans for Shetland. Habitats around the Proposed Development are detailed in Appendix 7.2: Phase 1 Habitat, NVC and Groundwater Dependent Terrestrial Ecosystems report.

SSSI citation data

Norwick Meadows SSSI is also very close to the Proposed New Section of Access Road at Northdale (ca. 200m south), Proposed Launch and Range Control Centre (ca. 230m north) and near to the Proposed Launch Site (ca. 600m south). Norwick Meadows SSSI is designated for its valley fen wetlands and sand dunes (NatureScot, 2020).

The SSSI citation for Norwick Meadows describes the habitats as "*On the eastern end of Norwick Meadows SSSI between the marsh and the sea, there is a small but floristically rich sand dune system with marram grass* Ammophila arenaria*, sand couch* Elymus farctus*, yarrow* Achillea millefolium*, tufted vetch* Vicia cracca *and meadow vetchling* Lathyrus pratensis*. The nationally scarce and locally rare sea pea* Lathyrus japonicus subsp. maritimus*, internationally rare and locally scarce autumn gentian* Gentianella amarella subsp. septentrionalis *and nationally scarce curved sedge* Carex maritima *have been recorded from the site. Norwick Meadows SSSI provides one of the best and most extensive examples of mesotrophic (moderately nutrient-rich) marsh in Shetland. The meadows are species-rich with much of the* *area dominated by bottle sedge* Carex rostrata *with bogbean* Menyanthes trifoliata*, marsh cinquefoil* Potentilla palustris *and amphibious bistort* Persicaria amphibiaalso *present. It is the most important site in Shetland for the locally rare white sedge* Carex curta*. The wettest parts of the marsh support the largest beds of mare's-tail* Hippuris vulgaris *in Shetland*".

Norwick Meadows NVC Survey data

The draft 1994 NVC survey of Norwick Meadows SSSI provides relatively detailed data on the SSSI (Smedley and Uttley, 1994, provided by Johnathan Swale of SNH in June 2018). It describes Norwick Meadows as: "*Norwick Meadows, along the Burn of Norwick, from Norwick Meadow to Northdale, consists of a valley fen, mainly* Carex rostrata – Potentilla palustris *tall-herb fen (S27) with localised development of mire communities, both poor- and rich-fen, including* Carex rostrata – Sphagnum squarrosum *mire (M5) and* Carex rostra – Calliergon cuspidatum/giganteum mire *(M9)."*

It goes on to describe the NVC communities:

- S27 *Carex rostrata – Potentilla palustris* tall-herb fen;
- M5 *Carex rostrata – Sphagnum squarrosum* mire;
- M6bi *Carex nigra – Sphagnum palustre/fallax; and*
- M9 *Carex rostra – Calliergon cuspidatum/giganteum.*

The report mentions the presence of MG8 *Cynosurus cristatus – Caltha palustris* grassland, S10 *Equisetetum fluviatile* swamp, S19 *Eleocharis palustris* swamp, S28 *Phalaris arundinacea* tall-herb fen, M28 *Iris pseudacorus – Filipendula ulmaria mire*, U6 *Juncus squarrosus – Festuca ovina* grassland, M25 *Molinia caerulea – Potentilla erecta* and MG12 *Festuca arundinacea* grassland within the SSSI boundary.

Sand Dune Vegetation Survey of Scotland

Inner Skaw, Wick of Skaw and Norwick formed part of the Shetland report of the Sand Dune Vegetation Survey of Scotland (SDVSS, Dargie, 1998a, 1998b, 1998c).

Inner Skaw is within the Proposed Launch Site boundary. The SDVSS survey reported a combination of SD4 *Elytrigia juncea* fore-dune community and SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community at Inner Skaw. SD8d was reported as the most common of the fixed dune grassland in Shetland and was considered to be generally species poor (Dargie, 1998a). MC8 *Festuca rubra – Holcus lanatus* maritime grassland was also recorded as the dune habitats transitioned to grassland.

Dargie (1998b) stated that "*The nature conservation interest of the site* [Inner Skaw] *is low due to small site area and limited range of vegetation*".

Similar NVC communities were reported at Wick of Skaw and Norwick, including:

- SD2 *Honkenya peploides – Cakile maritima* strandline community;

- SD4 *Elytrigia juncea* fore-dune community;
- SD8d *Festuca rubra – Galium verum* fixed dune grassland;
- MC8 *Festuca rubra – Holcus lanatus* maritime grassland;
- MG7 *Lolium perenne – Plantago lanceolata* community; and
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community.

Habitats in Shetland

In general, habitats in Shetland are reported to be "*strongly influenced by the islands' climate together with the nature of the terrain and underlying rocks*" as well as "*human influence on the natural heritage have been, and remain, strong*" (SNH, 2002). Habitats found across Shetland are discussed in a variety of published sources including the Habitat Actions Plans for freshwater (Hardy, 2004), strandlines (Davies and Gillham, 2004), ungrazed areas (Swale, 2004) and woodlands (McKenzie, Johnson, and Davies 2004); Scottish saltmarsh survey national report (Haynes, 2016) and Plantlife documents including "*A management Guide to Coastal grasslands*" (PlantLife, 2014).

Discussion

This desk study has identified several records of important ecological sensitivities within the Search Area, as far as existing and freely available data allows. Desk-based studies of this nature have limitations, such as the reliability of third-party records, the coverage of reported studies and the age of some records.

There was a relatively high number of records for some taxonomic groups e.g. birds, lichens, bryophytes and vascular plants for the Search Area, indicating a good base level of knowledge for these groups. However, there was a relatively paucity of biological records available for other taxonomic groups, such as Hymenoptera indicating either that there was a low of biodiversity within the Search Area and/or a low level of invertebrate biological recording.

There was some historic record of the habitats in and around the Search Area and general information available in relation to habitats found in Shetland.

It is important to understand that a lack of information for a species (or indeed Class/Order) does not necessarily mean absence and previous historical occurrence does not necessarily mean current presence.

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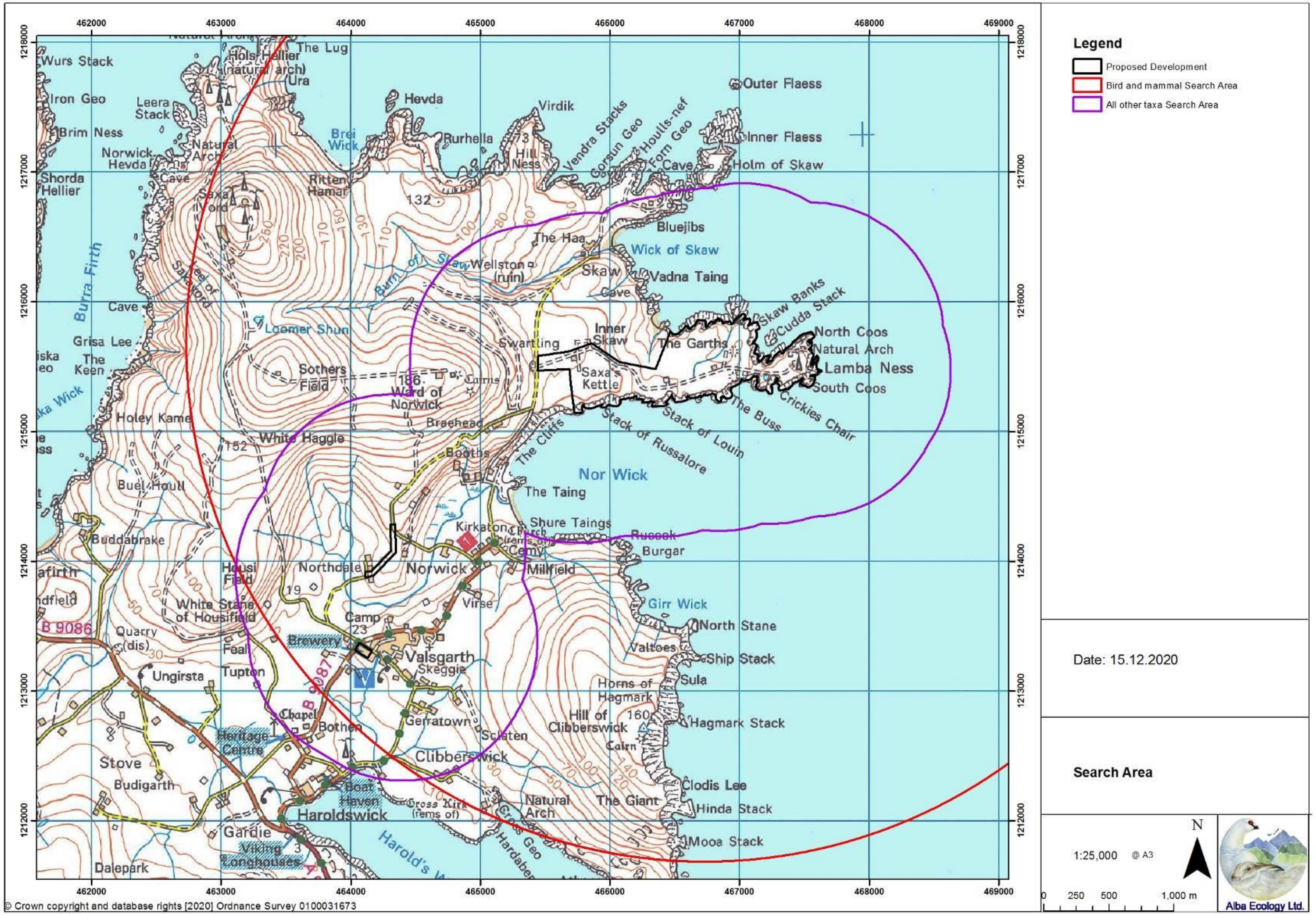
Appendix 7.1 Drawing 1: Desk Study Search Area



Species	Common Name	Reference(s)
Lutra lutra	European Otter	Shetland Biological Records Centre, 2002-2011
Rattus norvegicus	Brown Rat	Shetland Biological Records Centre, 1997-2004
Oryctolagus cuniculus	European Rabbit	Shetland Biological Records Centre, 2003
Cetorhinus maximus	Basking Shark	Shetland Biological Records Centre, 2011-2019
Cytophora cristata	Hooded Seal	Shetland Biological Records Centre, 2013
Balaenoptera acutorostrata	Minke Whale	Shetland Biological Records Centre, 2001-2019
Megaptera novaeangliae	Humpback Whale	Shetland Biological Records Centre, 2017
Globicephala melas	Long-finned Pilot Whale	Shetland Biological Records Centre, 2017
Grampus griseus	Risso's Dolphin	Shetland Biological Records Centre, 1991-2017
Lagenorhynchus acutus	Atlantic White-sided Dolphin	Shetland Biological Records Centre, 2001-2009
Lagenorhynchus albirostris	White-beaked Dolphin	Shetland Biological Records Centre, 2000-2003
Orcinus orca	Killer Whale	Shetland Biological Records Centre, 1990-2019
Phocoena phocoena	Common Porpoise	Shetland Biological Records Centre, 2002-2006
Erinaceus europaeus	West European Hedgehog	Shetland Biological Records Centre, 2002-2009
Chiroptera	Bats	Shetland Biological Records Centre, 2011-2015
Pipistrellus nathusii	Nathusius's Pipistrelle	Shetland Biological Records Centre, 1996-2011
Vespertilio murinus	Parti-coloured Bat	Shetland Biological Records Centre, 2003

Species	Common Name	Reference(s)
Cygnus olor	Mute Swan	Shetland Biological Records Centre, 2001-2019
Cygnus cygnus	Whooper Swan	
Anser fabalis	Bean Goose	
Anser fabalis subsp. rossicus	Tundra Bean Goose	
Anser brachyrhynchus	Pink-footed Goose	
Anser albifrons subsp. albifrons	European Greater White-fronted (	
Anser anser	Greylag Goose	
Branta canadensis	Canada Goose	
Branta leucopsis	Barnacle Goose	
Branta bernicla subsp. hrota	Light-bellied Brent Goose	
Tadorna tadorna	Shelduck	
Anas penelope	Wigeon	
Anas crecca	Teal	
Anas platyrhynchos	Mallard	
Anas acuta	Pintail	
Aythya ferina	Pochard	
Aythya fuligula	Tufted Duck	
Somateria mollissima	Eider	
Clangula hyemalis	Long-tailed Duck	
Melanitta nigra	Common Scoter	
Melanitta perspicillata	Surf Scoter	
Melanitta fusca	Velvet Scoter	
Bucephala clangula	Goldeneye	
Mergus cucullatus	Hooded Merganser	
Mergus serrator	Red-breasted Merganser	
Mergus merganser	Goosander	
Coturnix coturnix	Quail	
Gavia stellata	Red-throated Diver	
Gavia immer	Great Northern Diver	
Fulmarus glacialis	Fulmar	
Fulmarus glacialis subsp. glacialis	Fulmarus glacialis subsp. glacialis	
Phalacrocorax carbo	Cormorant	
Phalacrocorax aristotelis	Shag	
Ardea cinerea	Grey Heron	
Tachybaptus ruficollis	Little Grebe	
Podiceps auritus	Slavonian Grebe	
Rallus aquaticus	Water Rail	
Porzana porzana	Spotted Crake	
Crex crex	Corncrake	
Gallinula chloropus	Moorhen	
Fulica atra	Coot	
Grus grus	Crane	
Haematopus ostralegus	Oystercatcher	
Pluvialis apricaria	Golden Plover	
Vanellus vanellus	Lapwing	
Charadrius dubius	Little Ringed Plover	
Charadrius hiaticula	Ringed Plover	
Charadrius morinellus	Dotterel	
Numenius phaeopus	Whimbrel	
Numenius arquata	Curlew	
Limosa limosa	Black-tailed Godwit	
Arenaria interpres	Turnstone	
Calidris canutus	Knot	
Philomachus pugnax	Ruff	
Calidris ferruginea	Curlew Sandpiper	
Calidris alba	Sanderling	

Calidris alpina	Dunlin
Calidris maritima	Purple Sandpiper
Phalaropus lobatus	Red-necked Phalarope
Tringa nebularia	Greenshank
Tringa totanus	Redshank
Lymnocryptes minimus	Jack Snipe
Scolopax rusticola	Woodcock
Gallinago gallinago	Snipe
Stercorarius parasiticus	Arctic Skua
Fratercula arctica	Puffin
Cepphus grylle	Black Guillemot
Alca torda	Razorbill
Uria aalge	Guillemot
Sterna hirundo	Common Tern
Sterna paradisaea	Arctic Tern
Rissa tridactyla	Kittiwake
Chroicocephalus ridibundus	Black-headed Gull
Larus canus	Common Gull
Larus fuscus	Lesser Black-backed Gull
Larus fuscus subsp. graellsii	British Lesser Black-Backed Gull
Larus argentatus	Herring Gull
Larus glaucoides	Iceland Gull
Larus hyperboreus	Glaucous Gull
Larus marinus	Great Black-backed Gull
Columba palumbus	Woodpigeon
Falco columbarius	Merlin
Falco peregrinus	Peregrine
Corvus corone subsp. cornix	Hooded Crow
Alauda arvensis	Skylark
Hirundo rustica	Swallow
Delichon urbica	House Martin
Phylloscopus collybita	Chiffchaff
Hippolais icterina	Icterine Warbler
Acrocephalus palustris	Marsh Warbler
Troglodytes troglodytes	Wren
Sturnus vulgaris	Starling
Turdus merula	Blackbird
Turdus pilaris	Fieldfare
Turdus iliacus	Redwing
Oenanthe oenanthe	Wheatear
Passer domesticus	House Sparrow
Passer montanus	Tree Sparrow
Motacilla cinerea	Grey Wagtail
Motacilla alba subsp. yarrellii	Pied Wagtail
Motacilla alba subsp. alba	White Wagtail
Anthus pratensis	Meadow Pipit
Anthus petrosus	Rock Pipit
Actitis hypoleucos	Common Sandpiper
Stercorarius skua	Great Skua

Species	Common Name	Reference(s)
Rana temporaria	Common Frog	Shetland Biological records 1999

Species	Common Name	Reference(s)
Huperzia selago	Fir Clubmoss	Shetland Biological Records Centre, 1991-2018
Selaginella selaginoides	Lesser Clubmoss	
Equisetum arvense	Field Horsetail	
Equisetum fluviatile	Water Horsetail	
Equisetum palustre	Marsh Horsetail	
Polypodium vulgare agg.	Polypody	
Asplenium adiantum-nigrum	Black Spleenwort	
Blechnum spicant	Hard-fern	
Dryopteris dilatata	Broad Buckler-fern	
Hymenophyllum wilsonii	Wilson's Filmy-fern	
Botrychium lunaria	Moonwort	
Ophioglossum azoricum	Small Adder's-tongue	
Dryopteris filix-mas agg.	Male Fern	
Poa pratensis	Smooth Meadow-Grass	
Trichophorum cespitosum subsp. germanicum	Deergrass	
Callitriche stagnalis	Common Water-Starwort	
Trichophorum cespitosum	Deergrass	
Elytrigia repens subsp. repens	Common Couch	
Callitriche hamulata	Intermediate Water-Starwort	
Carex arenaria	Sand Sedge	
Carex bigelowii	Stiff Sedge	
Carex binervis	Green-ribbed Sedge	
Carex curta	White Sedge	
Carex echinata	Star Sedge	
Carex flacca	Glaucous Sedge	
Carex hostiana x viridula = C. x fulva	Sedge	
Carex limosa	Bog-sedge	
Carex nigra	Common Sedge	
Carex ovalis	Oval Sedge	
Carex panicea	Carnation Sedge	
Carex paniculata	Greater Tussock-sedge	
Carex pilulifera	Pill Sedge	
Carex pulicaris	Flea Sedge	
Carex rostrata	Bottle Sedge	
Carex viridula subsp. oedocarpa	Common Yellow-sedge	
Eleocharis palustris	Common Spike-rush	
Eriophorum angustifolium	Common Cottongrass	
Eriophorum vaginatum	Hare's-tail Cottongrass	
Crocosmia pottsii x aurea = C. x crocosmiiflora	Montbretia	
Iris pseudacorus	Yellow Iris	
Juncus articulatus	Jointed Rush	
Juncus bufonius	Toad Rush	
Juncus bulbosus	Bulbous Rush	
Juncus conglomeratus	Compact Rush	
Juncus effusus	Soft-rush	
Juncus squarrosus	Heath Rush	
Luzula campestris	Field Wood-rush	
Luzula multiflora	Heath Wood-rush	
Luzula multiflora subsp. congesta	Heath Wood-Rush	
Luzula multiflora subsp. multiflora	Heath Wood-Rush	
Luzula sylvatica	Great Wood-rush	
Triglochin palustre	Marsh Arrowgrass	
Hyacinthoides non-scripta x hispanica = H. x massartiana	Bluebell	
Narthecium ossifragum	Bog Asphodel	
Scilla verna	Spring Squill	
Coeloglossum viride	Frog Orchid	
Dactylorhiza	Marsh-Orchid	
Dactylorhiza fuchsii x purpurella = D. x venusta	Marsh-Orchid	
Dactylorhiza incarnata subsp. pulchella	Early Marsh-Orchid	
Dactylorhiza maculata	Heath Spotted-orchid	
Dactylorhiza purpurella	Northern Marsh-orchid	
Listera cordata	Lesser Twayblade	
Agrostis canina	Velvet Bent	
Agrostis capillaris	Common Bent	
Agrostis stolonifera	Creeping Bent	
Agrostis vinealis	Brown Bent	
Aira praecox	Early Hair-grass	
Atriplex prostrata agg.	Atriplex prostrata agg.	
Alopecurus geniculatus	Marsh Foxtail	
Alopecurus pratensis	Meadow Foxtail	
Ammophila arenaria	Marram	
Lychnis flos-cuculi	Ragged-Robin	
Anthoxanthum odoratum	Sweet Vernal-grass	
Arrhenatherum elatius	False Oat-grass	
Cochlearia officinalis agg.	Common Scurvygrass	
Bromus hordeaceus	Lesser Soft-Brome	
Cynosurus cristatus	Crested Dog's-tail	
Dactylis glomerata	Cock's-foot	
Deschampsia cespitosa	Tufted Hair-Grass	
Deschampsia flexuosa	Wavy Hair-grass	
Elytrigia juncea subsp. boreoatlantica	Sand Couch	
Elytrigia repens	Common Couch	
Festuca arundinacea	Tall Fescue	
Festuca rubra	Red Fescue	
Festuca rubra subsp. arctica	Red Fescue	
Festuca rubra subsp. rubra	Red Fescue	
Festuca vivipara	Viviparous Sheep's-fescue	
Glyceria fluitans	Floating Sweet-grass	
Holcus lanatus	Yorkshire-fog	
Leymus arenarius	Lyme-grass	
Lolium perenne	Perennial Rye-grass	
Molinia caerulea	Purple Moor-grass	

Nardus stricta	Mat-grass
Phalaris arundinacea	Reed Canary-grass
Poa annua	Annual Meadow-grass
Poa humilis	Spreading Meadow-grass
Poa trivialis	Rough Meadow-grass
Puccinellia distans	Reflexed Saltmarsh-Grass
Potamogeton	Pondweed
Potamogeton polygonifolius	Bog Pondweed
Typha latifolia	Bulrush
Angelica sylvestris	Wild Angelica
Anthriscus sylvestris	Cow Parsley
Conopodium majus	Pignut
Heracleum sphondylium	Hogweed
Heracleum sphondylium subsp. sphondylium	Hogweed
Hydrocotyle vulgaris	Marsh Pennywort
Ligusticum scoticum	Scots Lovage
Achillea millefolium	Yarrow
Achillea ptarmica	Sneezewort
Artemisia vulgaris	Mugwort
Aster novi-belgii	Confused Michaelmas-daisy
Bellis perennis	Daisy
Centaurea montana	Perennial Cornflower
Cichorium intybus	Chicory
Cirsium arvense	Creeping Thistle
Cirsium vulgare	Spear Thistle
Hypochaeris radicata	Cat's-ear
Leontodon autumnalis	Autumn Hawkbit
Matricaria discoidea	Pineappleweed
Petasites albus	White Butterbur
Senecio aquaticus	Marsh Ragwort
Senecio jacobaea	Common Ragwort
Senecio vulgaris	Groundsel
Solidago virgaurea	Goldenrod
Sonchus arvensis	Perennial Sow-thistle
Tanacetum vulgare	Tansy
Taraxacum	Dandelion Agg.
Taraxacum faeroense	Dandelion
Taraxacum officinale agg.	Dandelion
Tripleurospermum inodorum	Scentless Mayweed
Tripleurospermum maritimum	Sea Mayweed
Anchusa arvensis	Bugloss
Borago officinalis	Borage
Mertensia maritima	Oysterplant
Myosotis arvensis	Field Forget-me-not
Myosotis discolor	Changing Forget-me-not
Myosotis laxa	Tufted Forget-me-not
Myosotis scorpioides	Water Forget-me-not
Myosotis secunda	Creeping Forget-me-not
Arabis petraea	Northern Rock-cress
Cakile maritima	Sea Rocket
Cakile maritima subsp. integrifolia	Cakile maritima subsp. integrifolia
Capsella bursa-pastoris	Shepherd's-purse
Cardamine hirsuta	Hairy Bitter-cress
Cardamine pratensis	Cuckooflower
Cochlearia officinalis	Common Scurvygrass
Cochlearia officinalis subsp. officinalis	Scurvygrass
Crambe maritima	Sea-kale
Callitriche	Water-Starwort
Jasione montana	Sheep's-bit
Arenaria norvegica subsp. norvegica	Arctic Sandwort
Cerastium diffusum	Sea Mouse-ear
Cerastium fontanum	Common Mouse-ear
Cerastium fontanum subsp. holosteoides	Common Mouse-Ear
Cerastium glomeratum	Sticky Mouse-ear
Honckenya peploides	Sea Sandwort
Sagina maritima	Sea Pearlwort
Sagina procumbens	Procumbent Pearlwort
Silene acaulis	Moss Campion
Silene dioica	Red Campion
Silene uniflora	Sea Campion
Spergula arvensis	Corn Spurrey
Stellaria alsine	Bog Stitchwort
Stellaria uliginosa	Bog Stitchwort
Stellaria media	Common Chickweed
Atriplex glabriuscula	Babington's Orache
Atriplex prostrata	Spear-leaved Orache
Chenopodium album	Fat-hen
Convolvulus arvensis	Field Bindweed
Sedum rosea	Roseroot
Succisa pratensis	Devil's-bit Scabious
Drosera rotundifolia	Round-leaved Sundew
Empetrum nigrum	Crowberry agg.
Empetrum nigrum subsp. nigrum	Crowberry
Calluna vulgaris	Heather
Erica cinerea	Bell Heather
Erica tetralix	Cross-leaved Heath
Vaccinium myrtillus	Bilberry
Vaccinium uliginosum	Bog Bilberry
Vaccinium vitis-idaea	Cowberry
Anthyllis vulneraria	Kidney Vetch
Lathyrus japonicus	Sea Pea
Lathyrus pratensis	Meadow Vetchling
Lotus corniculatus	Common Bird's-foot-trefoil
Trifolium pratense	Red Clover

Trifolium repens	White Clover
Ulex europaeus	Gorse
Vicia cracca	Tufted Vetch
Vicia sepium	Bush Vetch
Gentianella campestris	Field Gentian
Geranium psilostemon	Armenian Crane's-bill
Geranium robertianum	Herb-Robert
Hippuris vulgaris	Mare's-tail
Lamium confertum	Northern Dead-nettle
Lamium purpureum	Red Dead-nettle
Mentha spicata	Spear Mint
Prunella vulgaris	Selfheal
Thymus polytrichus	Thymus polytrichus
Pinguicula vulgaris	Common Butterwort
Linum catharticum	Fairy Flax
Menyanthes trifoliata	Bogbean
Epilobium brunnescens	New Zealand Willowherb
Epilobium montanum	Broad-leaved Willowherb
Epilobium palustre	Marsh Willowherb
Papaver dubium	Long-headed Poppy
Plantago coronopus	Buck's-horn Plantain
Plantago lanceolata	Ribwort Plantain
Plantago major	Greater Plantain
Plantago major subsp. major	Greater Plantain
Plantago maritima	Sea Plantain
Armeria maritima subsp. maritima	Thrift
Polygala serpyllifolia	Heath Milkwort
Polygala vulgaris	Common Milkwort
Persicaria amphibia	Amphibious Bistort
Persicaria bistorta	Common Bistort
Persicaria maculosa	Redshank
Polygonum aviculare	Knotgrass
Polygonum boreale	Northern Knotgrass
Rheum palmatum x rhaponticum = R. x hybridum	Rhubarb
Rumex acetosa	Common Sorrel
Rumex acetosa subsp. acetosa	Common Sorrel
Rumex acetosella	Sheep's Sorrel
Rumex acetosella subsp. acetosella	Sheep's Sorrel
Rumex crispus	Curled Dock
Rumex crispus subsp. littoreus	Curled Dock
Rumex crispus x obtusifolius = R. x pratensis	Dock
Rumex longifolius	Northern Dock
Rumex obtusifolius	Broad-leaved Dock
Claytonia perfoliata	Springbeauty
Montia fontana	Blinks
Montia fontana subsp. fontana	Blinks
Anagallis tenella	Bog Pimpernel
Caltha palustris	Marsh-marigold
Ranunculus acris	Meadow Buttercup
Ranunculus ficaria	Lesser Celandine
Ranunculus ficaria subsp. ficaria	Lesser Celandine
Ranunculus flammula	Lesser Spearwort
Ranunculus flammula subsp. flammula	Lesser Spearwort
Ranunculus repens	Creeping Buttercup
Alchemilla glabra	Smooth Lady's-mantle
Potentilla erecta	Tormentil
Potentilla erecta subsp. erecta	Tormentil
Potentilla palustris	Marsh Cinquefoil
Rosa rugosa	Japanese Rose
Rubus idaeus	Raspberry
Galium aparine	Cleavers
Galium palustre	Marsh-bedstraw
Galium palustre subsp. palustre	Common Marsh-bedstraw
Galium saxatile	Heath Bedstraw
Galium verum	Lady's Bedstraw
Salix cinerea x phylicifolia = S. x laurina	Laurel-leaved Willow
Euphrasia	Eyebright
Euphrasia arctica	an Eyebright
Euphrasia micrantha	Eyebright
Euphrasia nemorosa	Eyebright
Euphrasia officinalis agg.	Eyebright
Hebe elliptica x speciosa = H. x franciscana	Hedge Veronica
Mimulus guttatus	Monkeyflower
Pedicularis palustris	Marsh Lousewort
Pedicularis sylvatica	Lousewort
Rhinanthus minor	Yellow-rattle
Rhinanthus minor subsp. stenophyllus	Yellow-Rattle
Scrophularia nodosa	Common Figwort
Veronica scutellata	Marsh Speedwell
Veronica serpyllifolia	Thyme-leaved Speedwell
Veronica serpyllifolia subsp. serpyllifolia	Thyme-Leaved Speedwell
Urtica dioica	Common Nettle
Viola arvensis	Field Pansy
Viola palustris	Marsh Violet
Viola palustris subsp. palustris	Marsh Violet
Viola riviniana	Common Dog-violet
Viola tricolor	Wild Pansy
Armeria maritima	Sea Pink
Potentilla anserina	Silverweed
Polypodium vulgare	Polypody

Species	Common Name	Liverwort/Moss	Reference
Aneura pinguis	Greasewort	Liverwort	Shetland Biological records 2008
Blepharostoma trichophyllum	Hairy Threadwort	Liverwort	Shetland Biological records 2008
Calypogeia fissa	Common Pouchwort	Liverwort	Shetland Biological records 2008
Calypogeia muelleriana	Mueller's Pouchwort	Liverwort	Shetland Biological records 2008
Cephalozia bicuspidata	Two-horned Pincerwort	Liverwort	Shetland Biological records 2008
Cephalozia leucantha	Pale Pincerwort	Liverwort	Shetland Biological records 2008
Cephaloziella divaricata	Common Threadwort	Liverwort	Shetland Biological records 2008
Cephaloziella hampeana	Hampe's Threadwort	Liverwort	Shetland Biological records 2008
Diplophyllum albicans	White Earwort	Liverwort	Shetland Biological records 2008
Kurzia trichoclados	Heath Fingerwort	Liverwort	Shetland Biological records 2008
Lepidozia reptans	Creeping Fingerwort	Liverwort	Shetland Biological records 2008
Lophocolea bidentata	Bifid Crestwort	Liverwort	Shetland Biological records 2008
Lophozia incisa	Jagged Notchwort	Liverwort	Shetland Biological records 2008
Lophozia ventricosa	Tumid Notchwort	Liverwort	Shetland Biological records 2001-2008
Lunularia cruciata	Crescent-cup Liverwort	Liverwort	Shetland Biological records 2008
Mylia anomala	Anomalous Flapwort	Liverwort	Shetland Biological records 2008
Mylia taylori	Taylor's Flapwort	Liverwort	Shetland Biological records 2001-2008
Nardia compressa	Compressed Flapwort	Liverwort	Shetland Biological records 2001
Pellia epiphylla	Overleaf Pellia	Liverwort	Shetland Biological records 2001-2008
Pellia neesiana	Nees' Pellia	Liverwort	Shetland Biological records 2001-2008
Ptilidium ciliare	Ciliated Fringewort	Liverwort	Shetland Biological records 2008
Riccardia latifrons	Bog Germanderwort	Liverwort	Shetland Biological records 2008
Scapania gracilis	Western Earwort	Liverwort	Shetland Biological records 2001-2008
Scapania undulata	Water Earwort	Liverwort	Shetland Biological records 2008
Tritomaria exsectiformis	Larger Cut Notchwort	Liverwort	Shetland Biological records 2008
Sphagnum	Bog Moss	Moss	Shetland Biological records 1991-2015
Aulacomnium palustre	Bog Groove-moss	Moss	Shetland Biological records 1991-2016
Barbula convoluta var. convoluta	Lesser Bird's-claw Beard-moss	Moss	Shetland Biological records 1991-2017
Barbula unguiculata	Bird's-claw Beard-moss	Moss	Shetland Biological records 1991-2018
Brachythecium rutabulum	Rough-stalked Feather-moss	Moss	Shetland Biological records 1991-2019
Bryum capillare	Capillary Thread-moss	Moss	Shetland Biological records 1991-2020
Bryum pseudotriquetrum	Marsh Bryum	Moss	Shetland Biological records 1991-2021
Calliergon giganteum	Giant Spear-moss	Moss	Shetland Biological records 1991-2022
Calliergon cuspidatum	Pointed Spear-moss	Moss	Shetland Biological records 1991-2023
Campylopus paradoxus	Rusty Swan-neck Moss	Moss	Shetland Biological records 1991-2024
Cratoneuron filicinum	Fern-leaved Hook-moss	Moss	Shetland Biological records 1991-2025
Dicranella varia	Variable Forklet-moss	Moss	Shetland Biological records 1991-2026
Dicranum bonjeanii	Crisped Fork-moss	Moss	Shetland Biological records 1991-2027
Dicranum fuscescens	Dusky Fork-moss	Moss	Shetland Biological records 1991-2028
Dicranum majus	Greater Fork-moss	Moss	Shetland Biological records 1991-2029
Dicranum scoparium	Broom Fork-moss	Moss	Shetland Biological records 1991-2030
Barbula fallax	Fallacious Beard-moss	Moss	Shetland Biological records 1991-2031
Barbula cylindrica	Cylindric Beard-moss	Moss	Shetland Biological records 1991-2032
Barbula rigidula	Rigid Beard-moss	Moss	Shetland Biological records 1991-2033
Drepanocladus revolvens	Rusty Hook-moss	Moss	Shetland Biological records 1991-2034
Eurhynchium praelongum	Common Feather-moss	Moss	Shetland Biological records 1991-2035
Homalothecium sericeum	Silky Wall Feather-moss	Moss	Shetland Biological records 1991-2036
Hylocomium splendens	Glittering Wood-moss	Moss	Shetland Biological records 1991-2037
Hypnum jutlandicum	Heath Plait-moss	Moss	Shetland Biological records 1991-2038
Isothecium myosuroides var. brach	Isothecium myosuroides var. brachythecioides	Moss	Shetland Biological records 1991-2039
Mnium hornum	Swan's-neck Thyme-moss	Moss	Shetland Biological records 1991-2040
Plagiomnium undulatum	Hart's-tongue Thyme-moss	Moss	Shetland Biological records 1991-2041
Polytrichum commune	Common Haircap	Moss	Shetland Biological records 1991-2042
Polytrichum commune var. commu	Polytrichum commune var. commune	Moss	Shetland Biological records 1991-2043
Polytrichum juniperinum	Juniper Haircap	Moss	Shetland Biological records 1991-2044
Polytrichum alpestre	Strict Haircap	Moss	Shetland Biological records 1991-2045
Barbula hornschuchiana	Hornschuch's Beard-moss	Moss	Shetland Biological records 1991-2046
Racomitrium lanuginosum	Woolly Fringe-moss	Moss	Shetland Biological records 1991-2047
Rhabdoweisia fugax	Dwarf Streak-moss	Moss	Shetland Biological records 1991-2048
Rhizomnium punctatum	Dotted Thyme-moss	Moss	Shetland Biological records 1991-2049
Rhytidiadelphus loreus	Little Shaggy-moss	Moss	Shetland Biological records 1991-2050
Rhytidiadelphus squarrosus	Springy Turf-moss	Moss	Shetland Biological records 1991-2051
Schistidium maritimum	Seaside Grimmia	Moss	Shetland Biological records 1991-2052
Sphagnum capillifolium	Red Bog-moss	Moss	Shetland Biological records 1991-2053
Sphagnum cuspidatum	Feathery Bog-moss	Moss	Shetland Biological records 1991-2054
Sphagnum recurvum var. mucronat	Flat-topped Bog-moss	Moss	Shetland Biological records 1991-2055
Sphagnum lindbergii	Lindberg's Bog-moss	Moss	Shetland Biological records 1991-2056
Sphagnum palustre	Blunt-leaved Bog-moss	Moss	Shetland Biological records 1991-2057
Sphagnum papillosum	Papillose Bog-moss	Moss	Shetland Biological records 1991-2058
Sphagnum squarrosum	Spiky Bog-moss	Moss	Shetland Biological records 1991-2059
Sphagnum subnitens	Lustrous Bog-moss	Moss	Shetland Biological records 1991-2060
Sphagnum tenellum	Soft Bog-moss	Moss	Shetland Biological records 1991-2061
Tortula muralis	Wall Screw-moss	Moss	Shetland Biological records 1991-2062
Drepanocladus fluitans	Floating Hook-moss	Moss	Shetland Biological records 1991-2063
Bryum bicolor	Bryum bicolor	Moss	Shetland Biological records 1991-2064
Hypnum cupressiforme	Hypnum cupressiforme	Moss	Shetland Biological records 1991-2065

Species	Common Name	Reference(s)
Acarospora fuscata		Shetland Biological Records Centre, 1990-2018
Agonimia tristicula		
Amandinea punctata		
Anaptychia runcinata		
Arthonia phaeobaea		
Arthonia varians		
Aspicilia caesiocinerea		
Aspicilia leprosescens		
Bacidia carneoglauca		
Bacidia scopulicola		
Baeomyces rufus		
Brigantiaea fuscolutea		
Caloplaca britannica		
Caloplaca ceracea		
Caloplaca crenularia		
Caloplaca crenulatella		
Caloplaca littorea		
Caloplaca marina	Orange Sea Lichen	
Caloplaca microthallina		
Caloplaca saxicola		
Caloplaca thallincola		
Caloplaca verruculifera	Orange Sea Star	
Candelariella vitellina		
Catapyrenium cinereum		
Cetraria aculeata		
Cetraria muricata		
Cladonia arbuscula subsp. squarrosa		
Cladonia bellidiflora		
Cladonia cervicornis subsp. cervicornis		
Cladonia ciliata var. tenuis		
Cladonia floerkeana		
Cladonia foliacea		
Cladonia gracilis		
Cladonia portentosa	Reindeer Moss	
Cladonia pyxidata		
Cladonia rangiformis		
Cladonia squamosa var. subsquamosa		
Cladonia subcervicornis		
Cladonia uncialis subsp. biuncialis		
Cliostomum griffithii		
Cliostomum tenerum		
Coccotrema citrinescens		
Evernia prunastri	Oak Moss	
Fuscidea cyathoides var. cyathoides		
Halecania ralfsii		
Hydropunctaria maura	Tar Lichen	
Hypogymnia physodes	Dark Crottle	
Ionaspis lacustris		
Lecania baeomma		
Lecanora albescens		
Lecanora confusa		
Lecanora expallens		
Lecanora farinaria		
Lecanora gangaleoides		
Lecanora helicopis		
Lecanora poliophaea		
Lecanora polytropa		
Lecanora pulicaris		
Lecanora rupicola var. rupicola		
Lecanora saligna		
Lecanora sulphurea		
Lecanora symmicta		
Lecanora umbrina		
Lecidea hypnorum		
Lecidea lactea		

Lecidella asema	
Lecidella meiococca	
Lecidella prasinula	
Lecidella scabra	
Lecidella stigmatea	
Leptogium britannicum	
Leptogium gelatinosum	
Lichenomphalia hudsoniana	
Lichina confinis	
Lichina pygmaea	Black Lichen
Lobaria virens	
Micarea lignaria	
Micarea peliocarpa	
Ochrolechia frigida	
Ochrolechia parella	Parelle
Opegrapha areniseda	
Opegrapha atra	
Opegrapha cesareensis	
Opegrapha multipuncta	
Pannaria pezizoides	
Parmelia omphalodes	
Parmelia saxatilis	Netted Shield Lichen
Parmelia sulcata	
Parmotrema chinense	
Parmotrema crinitum	Dog Lichen
Parmotrema perlatum	
Peltigera canina	
Peltigera hymenina	
Peltigera leucophlebia	
Peltigera membranacea	
Pertusaria albescens var. corallina	
Phaeophyscia orbicularis	
Physcia tenella	
Polyblastia cupularis	
Porina chlorotica f. chlorotica	
Porpidia macrocarpa	
Porpidia macrocarpa f. macrocarpa	
Porpidia platycarpoides	
Porpidia tuberculosa	
Protopannaria pezizoides	
Psoroma hypnorum	
Ramalina cuspidata	
Ramalina farinacea	Sea Ivory
Ramalina siliquosa	
Ramalina subfarinacea	
Rhizocarpon richardii	
Rinodina confragosa	
Rinodina oleae	
Roselliniopsis tartaricola	
Solorina spongiosa	
Sphaerophorus globosus	
Tephromela atra	
Tephromela grumosa	
Thelenella muscorum var. muscorum	
Thelenella muscorum var. octospora	
Toninia aromatica	
Trapelia coarctata	
Trapeliopsis pseudogranulosa	
Verrucaria fusconigrescens	Tar Lichen
Verrucaria maura	
Verrucaria nigrescens	
Violella fucata	Common Orange Lichen
Xanthoria aureola	
Xanthoria parietina	
Opegrapha calcarea	

Species	Common Name	Reference(s)
Dicymbium brevisetosum		Shetland Biologcal Records Centre 1991-2014
Hilaira frigida		
Lepthyphantes tenuis		
Lepthyphantes zimmermanni		
Lepthyphantes ericaeus		
Lepthyphantes mengei		
Latithorax faustus		
Meioneta beata		
Robertus lividus		
Ceratinella brevipes		
Walckenaeria clavicornis		
Walckenaeria nudipalpis		
Walckenaeria acuminata		
Dicymbium tibiale		
Hypomma bituberculatum		
Metopobactrus prominulus		
Gonatium rubens		
Peponocranium ludicrum		
Oedothorax gibbosus		
Oedothorax fuscus		
Silometopus elegans		
Cnephalocotes obscurus		
Tiso vagans		
Monocephalus castaneipes	Broad Groove-head Spider	
Lophomma punctatum		
Erigonella hiemalis		
Savignia frontata		
Diplocephalus permixtus		
Araeoncus crassiceps		
Scotinotylus evansi		
Pocadicnemis pumila		
Erigone arctica		
Erigone atra		
Erigone promiscua		
Leptorhoptrum robustum		
Micrargus herbigradus		
Agyneta decora		
Agyneta olivacea		
Centromerus prudens		
Meioneta saxatilis		
Centromerita bicolor		
Centromerita concinna		
Oreonetides vaginatus		
Saaristoa abnormis		
Bathyphantes gracilis		
Poeciloneta variegata		
Microlinyphia pusilla		
Allomengea scopigera		
Pardosa pullata		
Trochosa terricola		
Pirata piraticus		
Cryphoeca silvicola		
Amaurobius fenestralis		
Clubiona trivialis		

Xysticus cristatus
Ozyptila trux
Nemastoma bimaculatum
Mitopus morio

Species	Common Name	Reference(s)
Calathus melanocephalus		Shetland Biological Records Centre, 1991 - 2007
Agabus bipustulatus		Shetland Biological Records Centre, 2001
Agabus guttatus		Shetland Biological Records Centre, 2001
Hydroporus erythrocephalus		Shetland Biological Records Centre, 2001
Cychrus caraboides	Snail Hunter	Shetland Biological Records Centre, 2001 - 2007
Leistus rufescens		Shetland Biological Records Centre, 2004 - 2007
Nebria brevicollis		Shetland Biological Records Centre, 2001
Notiophilus palustris		Shetland Biological Records Centre, 2001
Loricera pilicornis		Shetland Biological Records Centre, 2001 - 2007
Trechus obtusus		Shetland Biological Records Centre, 2001 - 2007
Bembidion tetracolum		Shetland Biological Records Centre, 2001
Patrobus assimilis		Shetland Biological Records Centre, 2001 - 2007
Pterostichus oblongopunctatus		Shetland Biological Records Centre, 2001 - 2007
Pterostichus melanarius		Shetland Biological Records Centre, 2001
Pterostichus rhaeticus		Shetland Biological Records Centre, 2001 - 2007
Pterostichus strenuus		Shetland Biological Records Centre, 2001 - 2007
Calathus fuscipes		Shetland Biological Records Centre, 2001 - 2007
Agonum fuliginosum		Shetland Biological Records Centre, 2001 - 2007
Cercyon unipunctatus		Shetland Biological Records Centre, 2001
Megasternum obscurum		Shetland Biological Records Centre, 2001 - 2007
Leiodes obesa		Shetland Biological Records Centre, 2001 - 2007
Agathidium laevigatum		Shetland Biological Records Centre, 2001 - 2007
Olophrum piceum		Shetland Biological Records Centre, 2005 - 2007
Bryaxis bulbifer		Shetland Biological Records Centre, 2001
Tachinus signatus		Shetland Biological Records Centre, 2001 - 2007
Tachyporus dispar		Shetland Biological Records Centre, 2001 - 2007
Atheta graminicola		Shetland Biological Records Centre, 2001 - 2007
Boreophilia eremita		Shetland Biological Records Centre, 2001 - 2007
Geostiba circellaris		Shetland Biological Records Centre, 2001
Atheta fungi		Shetland Biological Records Centre, 2001
Anotylus rugosus		Shetland Biological Records Centre, 2001 - 2007
Stenus impressus		Shetland Biological Records Centre, 2001 - 2007
Stenus juno		Shetland Biological Records Centre, 2001 - 2007
Stenus brunnipes		Shetland Biological Records Centre, 2001
Lathrobium fulvipenne		Shetland Biological Records Centre, 2005 - 2007
Philonthus decorus		Shetland Biological Records Centre, 2001 - 2007
Quedius fuliginosus		Shetland Biological Records Centre, 2001
Quedius molochinus		Shetland Biological Records Centre, 2001 - 2007
Quedius umbrinus		Shetland Biological Records Centre, 2001 - 2007
Othius angustus		Shetland Biological Records Centre, 2001 - 2007
Byrrhus pilula	Pill Beetle	Shetland Biological Records Centre, 2005
Hypnoidus riparius		Shetland Biological Records Centre, 2001 - 2007
Dalopius marginatus		Shetland Biological Records Centre, 2001 - 2007
Anatis ocellata	Eyed Ladybird	Shetland Biological Records Centre, 1994 - 2009
Apion frumentarium		Shetland Biological Records Centre, 2004
Holotrichapion aethiops		Shetland Biological Records Centre, 2001 - 2005
Protapion assimile	Clover Seed Weevil	Shetland Biological Records Centre, 2005 - 2007
Barynotus squamosus		Shetland Biological Records Centre, 1991 - 2007
Otiorhynchus arcticus		Shetland Biological Records Centre, 1991 - 2007
Otiorhynchus singularis	Clay-coloured Weevil	Shetland Biological Records Centre, 2005 - 2007

Species	Common Name	Reference(s)
Pieris brassicae	Large White	Shetland Biological Records Centre, 1990-2017
Vanessa atalanta	Red Admiral	
Cynthia cardui	Painted Lady	
Aglais urticae	Small Tortoiseshell	
Inachis io	Peacock	
Paradiarsia glareosa subsp. glareosa	Autumnal Rustic	
Cydia succedana	Grey Gorse Piercer	
Hepialus humuli	Ghost Moth	
Zygaena filipendulae	Six-spot Burnet	
Anthophila fabriciana	Common Nettle-tap	
Glyphipterix thrasonella	Speckled Fanner	
Yponomeuta evonymella	Bird-cherry Ermine	
Plutella xylostella	Diamond-back Moth	
Rhigognostis senilella	Rock-cress Smudge	
Rhigognostis annulatella	Coast Smudge	
Elachista argentella	Swan-feather Dwarf	
Hofmannophila pseudospretella	Brown House-moth	
Endrosis sarcitrella	White-shouldered House-moth	
Depressaria badiella	False Brown Flat-body	
Agonopterix heracliana	Common Flat-body	
Bryotropha terrella	Cinerous Groundling	
Scrobipalpa samadensis subsp. plantaginella		
Aethes smeathmanniana	Yarrow Conch	
Eupoecilia angustana	Marbled Conch	
Syndemis musculana	Dark-barred Twist	
Clepsis senecionana	Obscure Twist	
Timandra griseata	Blood-Vein	
Eana osseana	Dotted Shade	
Eana penziana	Large Mottled Shade	
Eana penziana subsp. colquhounana		
Acleris sparsana	Ashy Button	
Acleris aspersana	Ginger Button	
Olethreutes lacunana	Common Marble	
Lobesia abscisana	Smoky-barred Marble	
Lobesia littoralis	Shore Marble	
Bactra lancealana	Rush Marble	
Epinotia mercuriana	Moorland Bell	
Rhopobota naevana	Holly Tortrix	
Eucosma cana	Hoary Belle	
Dichrorampha montanana	Spike-marked Drill	
Crambus lathoniellus	Hook-streak Grass-veneer	
Agriphila straminella	Straw Grass-veneer	
Agriphila tristella	Common Grass-veneer	
Scoparia subfusca	Large Grey	
Scoparia ambigualis	Common Grey	
Eudonia alpina	Highland Grey	
Eudonia angustea	Narrow-winged Grey	
Udea lutealis	Pale Straw Pearl	
Nomophila noctuella	Rush Veneer	
Pleuroptya ruralis	Mother of Pearl	
Dioryctria abietella	Dark Pine Knot-horn	
Scopula imitaria	Small Blood-vein	
Xanthorhoe munitata	Red Carpet	
Xanthorhoe decoloraria	Red Carpet	
Xanthorhoe montanata	Silver-ground Carpet	
Xanthorhoe fluctuata	Garden Carpet	
Entephria caesiata	Grey Mountain Carpet	
Eulithis testata	Chevron	
Eulithis populata	Northern Spinach	
Chloroclysta miata	Autumn Green Carpet	
Chloroclysta citrata	Dark Marbled Carpet	
Hydriomena furcata	July Highflyer	
Operophtera brumata	Winter Moth	
Perizoma albulata	Grass Rivulet	
Perizoma didymata	Twin-spot Carpet	
Eupithecia venosata	Netted Pug	
Eupithecia satyrata	Satyr Pug	
Eupithecia assimilata	Currant Pug	
Eupithecia pusillata	Juniper Pug	

Gymnoscelis rufifasciata	Double-striped Pug
Agrius convolvuli	Convolvulus Hawk-moth
Macroglossum stellatarum	Humming-bird Hawk-moth
Hyles galii	Bedstraw Hawk-moth
Arctia caja	Garden Tiger
Agrotis ipsilon	Dark Sword-grass
Standfussiana lucernea	Northern Rustic
Noctua pronuba	Large Yellow Underwing
Noctua fimbriata	Broad-bordered Yellow Underwing
Noctua janthe	Lesser Broad-bordered Yellow Underwing
Eugnorisma glareosa	Autumnal Rustic
Paradiarsia glareosa subsp. edda	Autumnal Rustic
Lycophotia porphyrea	True Lover's Knot
Diarsia mendica	Ingrailed Clay
Diarsia mendica subsp. thulei	Ingrailed Clay
Diarsia brunnea	Purple Clay
Diarsia rubi	Small Square-spot
Xestia c-nigrum	Setaceous Hebrew Character
Xestia baja	Dotted Clay
Xestia xanthographa	Square-spot Rustic
Eurois occulta	Great Brocade
Discestra trifolii	Nutmeg
Hada plebeja	Shears
Lacanobia suasa	Dog's Tooth
Lacanobia oleracea	Bright-Line Brown-Eye
Hadena confusa	Marbled Coronet
Hadena bicruris	Lychnis
Cerapteryx graminis	Antler Moth
Orthosia gothica	Hebrew Character
Mythimna pallens	Common Wainscot
Dasypolia templi	Brindled Ochre
Xylena vetusta	Red Sword-grass
Mniotype adusta	Dark Brocade
Eupsilia transversa	Satellite
Agrochola circellaris	Brick
Phlogophora meticulosa	Angle Shades
Enargia paleacea	Angle-striped Sallow
Parastichtis suspecta	Suspected
Cosmia trapezina	Dun-bar
Hepialus fusconebulosa	Map-winged Swift
Apamea monoglypha	Dark Arches
Apamea zeta	Exile
Apamea oblonga	Crescent Striped
Apamea crenata	Clouded-bordered Brindle
Apamea lateritia	Scarce Brindle
Apamea furva subsp. britannica	Confused
Apamea remissa	Dusky Brocade
Apamea ophiogramma	Double Lobed
Oligia fasciuncula	Middle-barred Minor
Mesapamea secalis	Common Rustic
Mesapamea didyma	Lesser Common Rustic
Photedes pygmina	Small Wainscot
Chortodes pygmina	Small Wainscot
Luperina testacea	Flounced Rustic
Amphipoea lucens	Large Ear
Amphipoea fucosa subsp. paludis	Saltern Ear
Hydraecia micacea	Rosy Rustic
Celaena haworthii	Haworth's Minor
Celaena leucostigma	Crescent
Plusia festucae	Gold Spot
Autographa gamma	Silver Y
Autographa pulchrina	Beautiful Golden Y
Syngrapha interrogationis	Scarce Silver Y

Species	Common Name	Reference(s)
Tipula varipennis		Shetland Biological Records Centre, 2014
Tipula paludosa		Shetland Biological Records Centre, 2008
Tipula lateralis		Shetland Biological Records Centre, 2008 - 2014
Erioptera trivialis		Shetland Biological Records Centre, 2008
Platycheirus clypeatus agg.	Platycheirus clypeatus agg.	Shetland Biological Records Centre, 2001
Empis tessellata		Shetland Biological Records Centre, 1983 - 2014
Empis trigramma		Shetland Biological Records Centre, 1983 - 2014
Episyrphus balteatus	Marmalade Hoverfly	Shetland Biological Records Centre, 1995 - 2016
Eristalis arbustorum		Shetland Biological Records Centre, 1990 - 2016
Eristalis intricarius		Shetland Biological Records Centre, 1990 - 2016
Eristalis pertinax		Shetland Biological Records Centre, 1995 - 2016
Eupeodes corollae		Shetland Biological Records Centre, 1894 - 2016
Eupeodes luniger		Shetland Biological Records Centre, 1995
Helophilus pendulus		Shetland Biological Records Centre, 1991 - 2016
Lejogaster metallina		Shetland Biological Records Centre, 1991 - 1996
Chrysogaster hirtella		Shetland Biological Records Centre, 1991 - 2014
Melanogaster hirtella		Shetland Biological Records Centre, 2014 - 2016
Melanostoma mellinum		Shetland Biological Records Centre, 1995 - 2015
Melanostoma scalare		Shetland Biological Records Centre, 1995 - 2016
Meliscaeva auricollis		Shetland Biological Records Centre, 1997 - 2014
Platycheirus albimanus		Shetland Biological Records Centre, 1995 - 2016
Platycheirus clypeatus		Shetland Biological Records Centre, 1996 - 2016
Platycheirus manicatus		Shetland Biological Records Centre, 1991 - 2016
Rhingia campestris		Shetland Biological Records Centre, 1991 - 2006
Scaeva pyrastri		Shetland Biological Records Centre, 1994 - 2016
Scaeva selenitica		Shetland Biological Records Centre, 1991- 2013
Sericomyia silentis		Shetland Biological Records Centre, 1991 - 2016
Syritta pipiens		Shetland Biological Records Centre, 1995 - 2014
Syrphus ribesii		Shetland Biological Records Centre, 1995 - 2016
Syrphus torvus		Shetland Biological Records Centre, 1995 - 2000
Xanthandrus comtus		Shetland Biological Records Centre, 2000 - 2015
Dioxyna bidentis		Shetland Biological Records Centre, 2015
Scathophaga stercoraria		Shetland Biological Records Centre, 1991 - 2014
Calliphora uralensis		Shetland Biological Records Centre, 1991 - 2014
Syrphus spp.		Shetland Biological Records Centre, 1995 - 2016
Melanostoma spp.		Shetland Biological Records Centre, 1995 - 2015

Species	Common Name	Reference(s)
Bombus muscorum	Moss Carder-bee	Shetland Biological Records Centre, 1991 - 2016
Bombus magnus	Northern White-tailed Bumblebee	Shetland Biological Records Centre, 1992 - 2016
Bombus hortorum	Small Garden Bumble Bee	Shetland Biological Records Centre, 1992 - 2014
Tenthredopsis coquebertii		Shetland Biological Records Centre, 2014
Bombus (Bombus) terrestris	Buff-Tailed Bumble Bee	Shetland Biological Records Centre, 2017-18

Species	Common Name	Reference(s)
Elasmostethus interstinctus	Birch Shieldbug	Shetland Biological Records Centre, 2002 - 2006

Licence	Rightsholder	Scientific Name	Common Name	Date	Data Provider	Institution Code	Kingdom	Phylum	Class	Order	Family	Genus
OGL		*Oligochaeta*	Earthworm	2005	Scottish Environment Protection Agency		Animalia	Annelida	Oligochaeta			
CC-BY		*Atomaria nitidula*		1960	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Coleoptera	Cryptophagidae	Atomaria
CC-BY		*Atomaria fuscipes*		1960	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Coleoptera	Cryptophagidae	Atomaria
CC0		*Boreonectes multilineatus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Boreonectes
CC0		*Hydroporus obscurus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Hydroporus tristis*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Hydroporus pubescens*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Hydroporus
CC0		*Rhantus suturellus*		1983	Balfour-Browne Club	Balfour-Browne Club	Animalia	Arthropoda	Insecta	Coleoptera	Dytiscidae	Rhantus
CC-BY	Highland Biological Recording Group	*Calliphora vicina*	Common Bluebottle	1983	Highland Biological Recording Group	HBRG	Animalia	Arthropoda	Insecta	Diptera	Calliphoridae	Calliphora
OGL		*Chironomidae*	Non-biting midges	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Chironomidae	
OGL		*Empididae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Empididae	
OGL		*Psychodidae*	Indet. Mothfly	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Psychodidae	
OGL		*Tipulidae*	Cranefly	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Diptera	Tipulidae	
CC-BY		*Wesmaelius (Kimminsia) subnebulosus*		1808	Biological Records Centre	Biological Records Centre	Animalia	Arthropoda	Insecta	Neuroptera	Hemerobiidae	Wesmaelius
OGL		*Chloroperlidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Plecoptera	Chloroperlidae	
OGL		*Leuctridae*	Needle or willow stoneflies	2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Plecoptera	Leuctridae	
CC-BY	UK Caddisfly Recording Scheme	*Lepidostoma hirtum*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Lepidostomatidae	Lepidostoma
CC-BY	UK Caddisfly Recording Scheme	*Athripsodes cinereus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Athripsodes
CC-BY	UK Caddisfly Recording Scheme	*Ceraclea fulva*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Ceraclea
CC-BY	UK Caddisfly Recording Scheme	*Mystacides azurea*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Leptoceridae	Mystacides
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus incisus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus lunatus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Limnephilus rhombicus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Limnephilus
CC-BY	UK Caddisfly Recording Scheme	*Mesophylax impunctatus*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Mesophylax
CC-BY	UK Caddisfly Recording Scheme	*Micropterna sequax*		1895	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	Micropterna
OGL		*Limnephilidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Trichoptera	Limnephilidae	
CC-BY	UK Caddisfly Recording Scheme	*Polycentropus flavomaculatus*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Polycentropodidae	Polycentropus
OGL		*Polycentropodidae*		2005	Scottish Environment Protection Agency		Animalia	Arthropoda	Insecta	Trichoptera	Polycentropodidae	
CC-BY	UK Caddisfly Recording Scheme	*Tinodes waeneri*		1889	Biological Records Centre	UK Caddisfly Recording Scheme	Animalia	Arthropoda	Insecta	Trichoptera	Psychomyiidae	Tinodes
OGL		*Semibalanus balanoides*	Acorn Barnacle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Arthropoda	Maxillopoda	Sessilia	Archaeobalanidae	Semibalanus
OGL		*Chthamalus stellatus*	Poli's Stellate Barnacle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Arthropoda	Maxillopoda	Sessilia	Chthamalidae	Chthamalus
CC-BY		*Anguilla anguilla*	European Eel	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Anguilliformes	Anguillidae	Anguilla
CC-BY		*Gasterosteus aculeatus*	Three-spined Stickleback	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Gasterosteiformes	Gasterosteidae	Gasterosteus
CC-BY		*Platichthys flesus*	Flounder	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Pleuronectiformes	Pleuronectidae	Platichthys
CC-BY		*Salmo salar*	Atlantic Salmon	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salmo
CC-BY		*Salmo trutta*	Brown/Sea Trout	2000	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Actinopterygii	Salmoniformes	Salmonidae	Salmo
CC-BY		*Vanellus vanellus*	Lapwing	2005	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Charadriidae	Vanellus
CC-BY		*Gallinago gallinago*	Snipe	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Gallinago
CC-BY		*Tringa totanus*	Redshank	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Tringa
CC-BY		*Numenius arquata*	Curlew	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Charadriiformes	Scolopacidae	Numenius
CC-BY		*Haliaeetus albicilla*	White-tailed Eagle	1983	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Falconiformes	Accipitridae	Haliaeetus
CC-BY		*Gavia stellata*	Red-throated Diver	1994	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Gaviiformes	Gaviidae	Gavia
CC-BY		*Crex crex*	Corncrake	2004	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Gruiformes	Rallidae	Crex
CC-BY		*Linaria flavirostris*	Twite	2006	Royal Society for the Protection of Birds		Animalia	Chordata	Aves	Passeriformes	Fringillidae	Linaria
CC-BY		*Phoca vitulina*	Harbour Seal	1970	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Mammalia	Carnivora	Phocidae	Phoca
CC-BY		*Halichoerus grypus*	Grey Seal	1970	Biological Records Centre	Biological Records Centre	Animalia	Chordata	Mammalia	Carnivora	Phocidae	Halichoerus
OGL		*Mytilus edulis*	Blue Mussel	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Bivalvia	Mytiloida	Mytilidae	Mytilus
OGL		*Littorina saxatilis/arcana*	Rough Periwinkle	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda	Littorinimorpha	Littorinidae	Littorina
OGL		*Nucella lapillus*	Dog Whelk	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda	Neogastropoda	Muricidae	Nucella
OGL		*Patella vulgata*	Common Limpet	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Animalia	Mollusca	Gastropoda		Patellidae	Patella
OGL		*Himanthalia elongata*	Thongweed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Fucales	Himanthaliaceae	Himanthalia
OGL		*Alaria esculenta*	Dabberlocks	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Laminariales	Alariaceae	Alaria
OGL		*Laminaria digitata*	Oarweed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Chromista	Ochrophyta	Phaeophyceae	Laminariales	Laminariaceae	Laminaria
CC-BY		*Arthonia radiata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Arthoniomycetes	Arthoniales	Arthoniaceae	Arthonia
CC-BY		*Acrocordia macrospora*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Dothideomycetes	Monoblastiales	Monoblastiaceae	Acrocordia
CC-BY		*Collemopsidium foveolatum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Dothideomycetes	Pyrenulales	Xanthopyreniaceae	Collemopsidium
CC-BY		*Verrucaria mucosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria viridula*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria hochstetteri*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria muralis*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Verrucaria striatula*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
OGL		*Verrucaria*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Fungi	Ascomycota	Eurotiomycetes	Verrucariales	Verrucariaceae	Verrucaria
CC-BY		*Polysporina simplex*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Acarosporales	Acarosporaceae	Polysporina
CC-BY		*Myriospora scabrida*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Acarosporales	Acarosporaceae	Myriospora
CC-BY		*Placynthiella uliginosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Baeomycetales	Trapeliaceae	Placynthiella
CC-BY		*Trapeliopsis granulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Baeomycetales	Trapeliaceae	Trapeliopsis
CC-BY		*Candelariella aurella f. aurella*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Candelariales	Candelariaceae	Candelariella
CC-BY		*Candelariella vitellina f. vitellina*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Candelariales	Candelariaceae	Candelariella
CC-BY		*Cladonia diversa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia cervicornis*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia coccifera s. lat.*	Scarlet-Cup Lichen	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia firma*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia ramulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia furcata subsp. furcata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia verticillata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia chlorophaea s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Cladonia pocillum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Cladoniaceae	Cladonia
CC-BY		*Myriolecis albescens*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Myriolecis dispersa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Lecidella elaeochroma f. elaeochroma*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Lecidella
CC-BY		*Lecanora campestris subsp. campestris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Lecanora
CC-BY		*Myriolecis actophila*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Myriolecis zosterae*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Lecanoraceae	Myriolecis
CC-BY		*Megalaria grossa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Megalariaceae	Megalaria
CC-BY		*Tephromela atra var. atra*	Black Shields	2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Mycoblastaceae	Tephromela
CC-BY		*Hypogymnia tubulosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Hypogymnia
CC-BY		*Parmelia saxatilis s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Parmelia
CC-BY		*Melanelixia fuliginosa*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Melanelixia
CC-BY		*Platismatia glauca*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Platismatia
CC-BY		*Pseudevernia furfuracea s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Pseudevernia
CC-BY		*Tuckermannopsis chlorophylla*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Tuckermannopsis
CC-BY		*Bryoria fuscescens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Parmeliaceae	Bryoria
CC-BY		*Micarea lignaria var. lignaria*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Pilocarpaceae	Micarea
CC-BY		*Protoblastenia rupestris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Psoraceae	Protoblastenia
CC-BY		*Lecania erysibe s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Ramalinaceae	Lecania

CC-BY		*Scoliciosporum umbrinum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Scoliciosporaceae	Scoliciosporum
CC-BY		*Lepraria finkii*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Stereocaulaceae	Lepraria
CC-BY		*Lepraria incana s. lat.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecanorales	Stereocaulaceae	Lepraria
CC-BY		*Porpidia speirea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Porpidia
CC-BY		*Lecidea berengeriana*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Lecidea
CC-BY		*Clauzadea monticola*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Clauzadea
CC-BY		*Porpidia crustulata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Lecideales	Lecideaceae	Porpidia
CC-BY		*Gyalecta foveolaris*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Ostropales	Gyalectaceae	Gyalecta
CC-BY		*Porina multipuncta*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Ostropales	Porinaceae	Porina
CC-BY		*Collema crispum var. crispum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Collema furfuraceum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Leptogium lichenoides*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Leptogium teretiusculum*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Collema tenax var. tenax*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Collema
CC-BY		*Leptogium pulvinatum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Collemataceae	Leptogium
CC-BY		*Pectenia plumbea s. lat.*	Bladder Stalks	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Pannariaceae	Pectenia
CC-BY		*Peltigera rufescens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Peltigeraceae	Peltigera
CC-BY		*Vahliella atlantica*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Peltigerales	Vahliellaceae	Vahliella
CC-BY		*Aspicilia contorta subsp. contorta*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Megasporaceae	Aspicilia
CC-BY		*Varicellaria lactea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Varicellaria
CC-BY		*Ochrolechia tartarea*	Cudbear	1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Ochrolechia androgyna*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Ochrolechia frigida f. frigida*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Ochrolechiaceae	Ochrolechia
CC-BY		*Pertusaria pseudocorallina*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Pertusariales	Pertusariaceae	Pertusaria
CC-BY		*Catillaria chalybeia var. chalybeia*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Rhizocarpales	Catillariaceae	Catillaria
CC-BY		*Rhizocarpon reductum*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Rhizocarpales	Rhizocarpaceae	Rhizocarpon
CC-BY		*Buellia stellulata*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Caliciaceae	Buellia
CC-BY		*Physcia adscendens*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Physciaceae	Physcia
CC-BY		*Caloplaca dichroa*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Caloplaca oasis*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Xanthoria ucrainica*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Xanthoria
CC-BY		*Caloplaca limonia*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Caloplaca holocarpa s. str.*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Xanthoria candelaria s. str.*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Xanthoria
CC-BY		*Caloplaca servidiella*		2015	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
OGL		*Caloplaca*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Fungi	Ascomycota	Lecanoromycetes	Teloschistales	Teloschistaceae	Caloplaca
CC-BY		*Fuscidea lygaea*		1960	British Lichen Society	British Lichen Society	Fungi	Ascomycota	Lecanoromycetes		Fuscideaceae	Fuscidea
CC-BY	Highland Biological Recording Group	*Puccinia urticata*	Cawod Goch Danadl	2014	Highland Biological Recording Group	HBRG	Fungi	Basidiomycota	Pucciniomycetes	Pucciniales	Pucciniaceae	Puccinia
CC-BY	British Bryological Society	*Archidium alternifolium*	Clay Earth-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Archidiales	Archidiaceae	Archidium
CC-BY	British Bryological Society	*Breutelia chrysocoma*	Golden-head Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bartramiaceae	Breutelia
CC-BY	British Bryological Society	*Philonotis fontana*	Fountain Apple-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bartramiaceae	Philonotis
CC-BY	British Bryological Society	*Bryum dichotomum*		2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Anomobryum julaceum*			British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Anomobryum
CC-BY	British Bryological Society	*Bryum pallens*	Pale Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Bryum argenteum*	Silver-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Bryum alpinum*	Alpine Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Bryaceae	Bryum
CC-BY	British Bryological Society	*Pohlia camptotrachela*	Crookneck Nodding-moss	1969	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Pohlia nutans*	Nodding Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Pohlia annotina*	Pale-fruited Thread-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Bryales	Mielichhoferiaceae	Pohlia
CC-BY	British Bryological Society	*Dicranum elongatum*	Dense Fork-moss	1907	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranum
CC-BY	British Bryological Society	*Dicranella heteromalla*	Silky Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranella
CC-BY	British Bryological Society	*Dicranella subulata*	Awl-leaved Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Dicranaceae	Dicranella
CC-BY	British Bryological Society	*Distichium capillaceum*	Fine Distichium		British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Distichium
CC-BY	British Bryological Society	*Pseudephemerum nitidum*	Delicate Earth-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Pseudephemerum
CC-BY	British Bryological Society	*Ceratodon purpureus*	Redshank	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Ditrichaceae	Ceratodon
CC-BY	British Bryological Society	*Fissidens osmundoides*	Purple-stalked Pocket-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Fissidentaceae	Fissidens
CC-BY	British Bryological Society	*Fissidens adianthoides*	Maidenhair Pocket-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Fissidentaceae	Fissidens
CC-BY	British Bryological Society	*Campylopus schimperi*	Schimper's Swan-neck Moss	1878	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus brevipilus*	Compact Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus fragilis*	Brittle Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Leucobryum glaucum*	Large White-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Leucobryum
CC-BY	British Bryological Society	*Campylopus pyriformis*	Dwarf Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Campylopus flexuosus*	Rusty Swan-neck Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Leucobryaceae	Campylopus
CC-BY	British Bryological Society	*Dichodontium pellucidum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Rhabdoweisiaceae	Dichodontium
CC-BY	British Bryological Society	*Dichodontium palustre*	Marsh Forklet-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Dicranales	Rhabdoweisiaceae	Dichodontium
CC-BY	British Bryological Society	*Entosthodon obtusus*	Blunt Cord-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Funariales	Funariaceae	Entosthodon
CC-BY	British Bryological Society	*Racomitrium fasciculare*	Green Mountain Fringe-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Racomitrium canescens*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Racomitrium aciculare*	Yellow Fringe-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Racomitrium
CC-BY	British Bryological Society	*Grimmia pulvinata*	Grey-cushioned Grimmia	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Grimmia
CC-BY	British Bryological Society	*Schistidium apocarpum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Grimmiales	Grimmiaceae	Schistidium
CC-BY	British Bryological Society	*Hookeria lucens*	Shining Hookeria	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hookeriales	Hookeriaceae	Hookeria
CC-BY	British Bryological Society	*Campylium stellatum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Amblystegiaceae	Campylium
CC-BY	British Bryological Society	*Hygrohypnum ochraceum*	Claw Brook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Amblystegiaceae	Hygrohypnum
CC-BY	British Bryological Society	*Kindbergia praelonga*	Common Feather-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Kindbergia
CC-BY	British Bryological Society	*Brachythecium albicans*	Whitish Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Brachythecium
CC-BY	British Bryological Society	*Pseudoscleropodium purum*	Neat Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Brachytheciaceae	Pseudoscleropodium
CC-BY	British Bryological Society	*Scorpidium cossonii*	Intermediate Hook-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Sarmentypnum exannulatum*	Ringless Hook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Sarmentypnum
CC-BY	British Bryological Society	*Calliergon cordifolium*	Heart-leaved Spear-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Calliergon
CC-BY	British Bryological Society	*Scorpidium scorpioides*	Hooked Scorpion-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Warnstorfia fluitans*	Floating Hook-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Warnstorfia
CC-BY	British Bryological Society	*Scorpidium revolvens*	Rusty Hook-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Calliergonaceae	Scorpidium
CC-BY	British Bryological Society	*Fontinalis antipyretica*	Greater Water-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Fontinalaceae	Fontinalis
CC-BY	British Bryological Society	*Rhytidiadelphus triquetrus*	Big Shaggy-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hylocomiaceae	Rhytidiadelphus
CC-BY	British Bryological Society	*Pleurozium schreberi*	Red-stemmed Feather-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hylocomiaceae	Pleurozium
CC-BY	British Bryological Society	*Calliergonella cuspidata*	Pointed Spear-moss	1996	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Calliergonella
CC-BY	British Bryological Society	*Hypnum cupressiforme var. resupinatum*	Supine Plait-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Hypnum
CC-BY	British Bryological Society	*Hypnum cupressiforme var. lacunosum*	Great Plait-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Hypnum
CC-BY	British Bryological Society	*Ctenidium molluscum*	Chalk Comb-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Hypnaceae	Ctenidium
CC-BY	British Bryological Society	*Isothecium myosuroides*	Slender Mouse-tail Moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Lembophyllaceae	Isothecium
CC-BY	British Bryological Society	*Antitrichia curtipendula*	Pendulous Wing-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Leucodontaceae	Antitrichia
CC-BY	British Bryological Society	*Thamnobryum alopecurum*	Fox-tail Feather-moss	1907	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Neckeraceae	Thamnobryum
CC-BY	British Bryological Society	*Plagiothecium undulatum*	Waved Silk-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Plagiotheciaceae	Plagiothecium
CC-BY	British Bryological Society	*Thuidium tamariscinum*	Common Tamarisk-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Hypnales	Thuidiaceae	Thuidium
CC-BY	British Bryological Society	*Ulota phyllantha*	Frizzled Pincushion	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Orthotrichales	Orthotrichaceae	Ulota

CC-BY	British Bryological Society	*Zygodon viridissimus var. viridissimus*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Orthotrichales	Orthotrichaceae	Zygodon
CC-BY	British Bryological Society	*Didymodon rigidulus*	Rigid Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Pseudocrossidium hornschuchianum*	Hornschuch's Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Pseudocrossidium
CC-BY	British Bryological Society	*Barbula convoluta*		2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Barbula
CC-BY	British Bryological Society	*Didymodon insulanus*	Cylindric Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Didymodon fallax*	Fallacious Beard-moss	2008	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Hymenostylium recurvirostrum*	Hook-beak Tufa-moss		British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Hymenostylium
CC-BY	British Bryological Society	*Tortula subulata*	Awl-leaved Screw-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Tortula
CC-BY	British Bryological Society	*Tortella tortuosa*	Frizzled Crisp-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Tortella
CC-BY	British Bryological Society	*Didymodon tophaceus*	Olive Beard-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Didymodon
CC-BY	British Bryological Society	*Trichostomum brachydontium*	Variable Crisp-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Trichostomum
CC-BY	British Bryological Society	*Bryoerythrophyllum recurvirostrum*	Red Beard-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Bryoerythrophyllum
CC-BY	British Bryological Society	*Weissia brachycarpa*	Small-mouthed Beardless-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Bryopsida	Pottiales	Pottiaceae	Weissia
CC-BY	British Bryological Society	*Oligotrichum hercynicum*	Hercynian Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Oligotrichum
CC-BY	British Bryological Society	*Pogonatum aloides*	Aloe Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Pogonatum
CC-BY	British Bryological Society	*Pogonatum urnigerum*	Urn Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Pogonatum
CC-BY	British Bryological Society	*Polytrichastrum alpinum*	Alpine Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichastrum
CC-BY	British Bryological Society	*Polytrichum piliferum*	Bristly Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichum
CC-BY	British Bryological Society	*Polytrichum strictum*	Strict Haircap	1974	British Bryological Society	BBS	Plantae	Bryophyta	Polytrichopsida	Polytrichales	Polytrichaceae	Polytrichum
CC-BY	British Bryological Society	*Sphagnum teres*	Rigid Bog-moss		British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum fimbriatum*	Fringed Bog-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum denticulatum*	Cow-horn Bog-moss	1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
CC-BY	British Bryological Society	*Sphagnum recurvum*		1974	British Bryological Society	BBS	Plantae	Bryophyta	Sphagnopsida	Sphagnales	Sphagnaceae	Sphagnum
OGL		*Cladophora*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Chlorophyta	Ulvophyceae	Cladophorales	Cladophoraceae	Cladophora
OGL		*Enteromorpha*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Chlorophyta	Ulvophyceae	Ulvales	Ulvaceae	Enteromorpha
CC-BY	British Bryological Society	*Fossombronia incurva*	Weedy Frillwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Fossombroniales	Fossombroniaceae	Fossombronia
CC-BY	British Bryological Society	*Calypogeia sphagnicola*	Bog Pouchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Calypogeiaceae	Calypogeia
CC-BY	British Bryological Society	*Hygrobiella laxifolia*	Lax Notchwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Cephaloziaceae	Hygrobiella
CC-BY	British Bryological Society	*Cephalozia loitlesbergeri*	Scissors Pincerwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Cephaloziaceae	Cephalozia
CC-BY	British Bryological Society	*Harpanthus flotovianus*	Great Mountain Flapwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Harpanthus
CC-BY	British Bryological Society	*Harpanthus scutatus*	Stipular Flapwort	1878	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Harpanthus
CC-BY	British Bryological Society	*Saccogyna viticulosa*	Straggling Pouchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Geocalycaceae	Saccogyna
CC-BY	British Bryological Society	*Marsupella emarginata*	Notched Rustwort	1878	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Gymnomitriaceae	Marsupella
CC-BY	British Bryological Society	*Marsupella emarginata var. emarginata*		1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Gymnomitriaceae	Marsupella
CC-BY	British Bryological Society	*Herbertus stramineus*	Straw Prongwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Herbertaceae	Herbertus
CC-BY	British Bryological Society	*Nardia scalaris*	Ladder Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Nardia
CC-BY	British Bryological Society	*Solenostoma paroicum*	Round-fruited Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Solenostoma
CC-BY	British Bryological Society	*Solenostoma gracillimum*	Crenulated Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Jungermanniaceae	Solenostoma
CC-BY	British Bryological Society	*Kurzia pauciflora*	Bristly Fingerwort		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lepidoziaceae	Kurzia
CC-BY	British Bryological Society	*Bazzania tricrenata*	Lesser Whipwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lepidoziaceae	Bazzania
CC-BY	British Bryological Society	*Chiloscyphus pallescens*	St Winifrid's Other Moss		British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Lophocoleaceae	Chiloscyphus
CC-BY	British Bryological Society	*Mylia taylorii*	Taylor's Flapwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Myliaceae	Mylia
CC-BY	British Bryological Society	*Plagiochila punctata*	Spotty Featherwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Plagiochilaceae	Plagiochila
CC-BY	British Bryological Society	*Plagiochila porelloides*	Lesser Featherwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Plagiochilaceae	Plagiochila
CC-BY	British Bryological Society	*Lophozia sudetica*	Hill Notchwort	1907	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Lophozia
CC-BY	British Bryological Society	*Diplophyllum obtusifolium*	Blunt-leaved Earwort	1843	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Diplophyllum
CC-BY	British Bryological Society	*Gymnocolea inflata*	Inflated Notchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Gymnocolea
CC-BY	British Bryological Society	*Scapania scandica*	Norwegian Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Scapania irrigua*	Heath Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Tritomaria quinquedentata*	Lyon's Notchwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Tritomaria
CC-BY	British Bryological Society	*Scapania degenii*	Degen's Earwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Jungermanniales	Scapaniaceae	Scapania
CC-BY	British Bryological Society	*Riccardia multifida*	Delicate Germanderwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Metzgeriales	Aneuraceae	Riccardia
CC-BY	British Bryological Society	*Metzgeria furcata*	Forked Veilwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Metzgeriales	Metzgeriaceae	Metzgeria
CC-BY	British Bryological Society	*Pellia endiviifolia*	Endive Pellia	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Pelliales	Pelliaceae	Pellia
CC-BY	British Bryological Society	*Frullania teneriffae*	Sea Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Frullania tamarisci*	Tamarisk Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Frullania dilatata*	Dilated Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Frullaniaceae	Frullania
CC-BY	British Bryological Society	*Lejeunea patens*	Pearl Pouncewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Lejeuneaceae	Lejeunea
CC-BY	British Bryological Society	*Radula complanata*	Even Scalewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Jungermanniopsida	Porellales	Radulaceae	Radula
CC-BY	British Bryological Society	*Blasia pusilla*	Common Kettlewort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Blasiales	Blasiaceae	Blasia
CC-BY	British Bryological Society	*Marchantia polymorpha subsp. montivagans*		1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Marchantiales	Marchantiaceae	Marchantia
CC-BY	British Bryological Society	*Marchantia polymorpha*	Common Liverwort	1974	British Bryological Society	BBS	Plantae	Marchantiophyta	Marchantiopsida	Marchantiales	Marchantiaceae	Marchantia
OGL		*Porphyra*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Bangiophyceae	Bangiales	Bangiaceae	Porphyra
OGL		*Ceramium*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Ceramiales	Ceramiaceae	Ceramium
OGL		*Membranoptera alata*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Ceramiales	Delesseriaceae	Membranoptera
OGL		*Corallina officinalis*	Coral Weed	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Corallinales	Corallinaceae	Corallina
OGL		*Lithothamnion*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Corallinales	Hapalidiaceae	Lithothamnion
OGL		*Mastocarpus stellatus*	False Irish Moss	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Gigartinales	Phyllophoraceae	Mastocarpus
OGL		*Rhodymenia*		1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta	Florideophyceae	Rhodymeniales	Rhodymeniaceae	Rhodymenia
OGL		*Rhodophyta*	Dark red crusts	1974	Joint Nature Conservation Committee	Joint Nature Conservation Committee	Plantae	Rhodophyta				
CC0	BSBI	*Aegopodium podagraria*	Ground-elder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Apiales	Apiaceae	Aegopodium
CC0	BSBI	*Allium moly*	Yellow Garlic	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Amaryllidaceae	Allium
CC0	BSBI	*Crocosmia paniculata*	Aunt-Eliza	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Iridaceae	Crocosmia
CC0	BSBI	*Kniphofia uvaria*	Red-hot-poker	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asparagales	Xanthorrhoeaceae	Kniphofia
CC0	BSBI	*Artemisia abrotanum*	Southernwood	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Artemisia
CC0	BSBI	*Calendula officinalis*	Pot Marigold	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Calendula
CC0	BSBI	*Aster novi-belgii x lanceolatus = A. x salignus*	Common Michaelmas-daisy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Asterales	Asteraceae	Aster
CC0	BSBI	*Hesperis matronalis*	Dame's-violet	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Brassicales	Brassicaceae	Hesperis
CC0	BSBI	*Sambucus nigra*	Elder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Adoxaceae	Sambucus
CC0	BSBI	*Symphoricarpos albus*	Snowberry	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Caprifoliaceae	Symphoricarpos
CC0	BSBI	*Lonicera periclymenum*	Honeysuckle	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Dipsacales	Caprifoliaceae	Lonicera
CC0	BSBI	*Lysimachia punctata*	Dotted Loosestrife	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ericales	Primulaceae	Lysimachia
CC0	BSBI	*Lupinus arboreus x polyphyllus = L. x regalis*	Russell Lupin	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Fabales	Fabaceae	Lupinus
CC0	BSBI	*Alnus viridis*	Green Alder	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Fagales	Betulaceae	Alnus
CC0	BSBI	*Geranium pratense*	Meadow Crane's-bill	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Geraniales	Geraniaceae	Geranium
CC0	BSBI	*Salix hookeriana*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Malpighiales	Salicaceae	Salix
CC0	BSBI	*Sidalcea*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Malvales	Malvaceae	Sidalcea
CC0	BSBI	*Chamerion angustifolium*	Rosebay Willowherb	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Myrtales	Onagraceae	Chamerion
CC0	BSBI	*Fuchsia magellanica*	Ffiwsia	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Myrtales	Onagraceae	Fuchsia
CC0	BSBI	*Meconopsis cambrica*	Welsh Poppy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Papaveraceae	Meconopsis
CC0	BSBI	*Papaver pseudoorientale*	Oriental Poppy	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Papaveraceae	Papaver
CC0	BSBI	*Thalictrum minus*	Lesser Meadow-rue	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Ranunculales	Ranunculaceae	Thalictrum
CC0	BSBI	*Geum*		2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Rosales	Rosaceae	Geum
CC0	BSBI	*Sedum spectabile*	Butterfly Stonecrop	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Crassulaceae	Sedum
CC0	BSBI	*Paeonia officinalis*	Garden Peony	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Paeoniaceae	Paeonia
CC0	BSBI	*Saxifraga umbrosa x spathularis = S. x urbium*	Londonpride	2015	Botanical Society of Britain & Ireland	BSBI	Plantae	Tracheophyta	Magnoliopsida	Saxifragales	Saxifragaceae	Saxifraga

Appendix 6.2 SaxaVord Spaceport Phase 1 Habitat, NVC and Potential GWDTE Survey Report

Phase 1 Habitat, National Vegetation Classification and Groundwater Dependent Terrestrial Ecosystems Survey Report for the Shetland Space Centre, Unst

August 2020, updated December 2020

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Summary

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to survey and map the habitats and plant communities within the boundary of the proposed development plus appropriate buffer zones. The proposal comprises of work in three discrete areas: (i) a Satellite Launch Facility at Lamba Ness, (ii) Saxa Vord Resort, and (iii) a new road at Northdale. This report considers all three of these Study Areas.

Field survey work was undertaken in July 2018 and updated in July 2020. Fieldwork included an extended Phase 1 Habitat survey, a National Vegetation Classification (NVC) survey and an assessment of wetland habitats. Habitats and community types were described and mapped, species lists were compiled and target notes made. From this, an assessment of potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) was made and is reported on.

The Satellite Launch Facility Study Area held a variety of habitats and communities, the most common of which were wet modified bog, wet modified bog/wet heath and coastal grassland. Appendix 7.2 Drawing 2 displays all the Phase 1 Habitats found in the Satellite Launch Facility Study Area and Table 3 lists the Phase 1 Habitats and the total area of each habitat mapped. Appendix 7.2 Drawing 3 displays the NVC communities that were described and mapped in the Study Area.

The wet modified bog, wet modified bog/wet heath, dry dwarf shrub heath, blanket bog, sand dune, coastal grassland, acid flush and some water margin vegetation habitats were evaluated as approaching or being equivalent to the descriptions of the Scottish Biodiversity List (SBL) habitats and/or Annex 1 habitat descriptions. The sand dunes and a water margin habitat were assessed as being of regional importance. The other habitats were evaluated as being of local importance due to a combination of factors including condition, size and the widespread nature of the habitat types in Shetland. Several habitats, including wet modified bog and neutral grassland, were assessed as being potentially moderately groundwater dependent. The acid flush habitat (NVC community M6) was assessed as being a potentially highly GWDTE.

The Saxa Vord Study Area held a small number of habitats and communities, all of which are common in and around built-up areas and agricultural land. These included frequently mown amenity grassland, improved grassland, buildings and roads and small patches of neutral grassland. None of these habitats were considered to have particular ecological importance or sensitivities. Japanese knotweed, a non-native invasive species, is known to be present on Unst, including a patch near the Saxa Vord Study Area, and so a watching brief should be kept for this species.

The Northdale Road Study Area held a small number of habitats, which were considered to be typical of Shetland. These included dry dwarf shrub heath, acid grassland, improved grassland and small patches of neutral grassland mapped as a mosaic with the acid grassland and improved grassland. The dry dwarf shrub heath was evaluated as being of local importance.

The very small amount of MG9 and MG10 grassland in the Northdale Road Study Area and the MG10 grassland in the Saxa Vord Study Area was assessed as being potentially moderately groundwater dependent. It was assessed as being potentially hydrologically connected to the nationally important, designated wetland habitats in Norwick Meadows SSSI. Care should be taken to ensure there are no direct or indirect impacts on the potentially sensitive habitats and the adjacent designated site.

Introduction

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to survey and map the habitats and plant communities within the boundary of the proposed development plus appropriate buffer zones which together form the Study Area. Alba Ecology Ltd. was commissioned by the developer to conduct a Phase 1 Habitat and National Vegetation Classification (NVC) survey and to report on Groundwater Dependent Terrestrial Ecosystems (GWDTE). The proposal comprises of work in three discrete areas: (i) a Satellite Launch Facility at Lamba Ness, (ii) Saxa Vord Resort, and (iii) a new road at Northdale. This report considers all three of these areas.

This document reports the findings of the Phase 1 Habitat and NVC survey and GWDTE assessment of the three Study Areas that was undertaken by Alba Ecology Ltd. in July 2018 and updated in July 2020.

Aims and Objectives

The objectives for this survey and report are:

- To identify, map and describe Phase 1 Habitats and NVC communities in the three Study Areas;
- To identify any particularly important habitats and species in the three Study Areas;
- To identify if any wetland habitats present are potential GWDTEs; and
- To evaluate the vegetation identified, with an appraisal of implications for the proposed Shetland Space Centre according to Ecological Impact Assessment (EcIA) guidelines (CIEEM, 2018).

Study Area

The proposal comprises of work in three discrete Study Areas: the Satellite Launch Facility Study Area, Saxa Vord Study Area and the Northdale Road Study Area (Appendix 7.2 Drawings 1 and 2).

Satellite Launch Facility Study Area

The centre of the Satellite Launch Facility Study Area is situated at approximate OS Grid reference HP660155, north to the village of Norwick in northeast Unst (Appendix 7.2 Drawing 1). The Satellite Launch Facility Study Area comprised of the proposed Application Boundary, plus a 250m buffer. It extended from the eastward tip of Lamba Ness, to west of the road at Swartling. This gives an area of 137ha (1.37km^2). A location map can be seen in Appendix 7.2 Drawing 1 with this Satellite Launch Facility Study Area indicated with a red outline.

The Satellite Launch Facility Study Area includes the sea cliffs of Lamba Ness with maritime grassland habitats. Further to the west the habitats transition into more upland heath and blanket bog habitats. Current and historic land uses were evident across the Satellite Launch Facility Study Area. There are a series of old, derelict, military buildings, roads and foundations from World War II. Currently the area is grazed by sheep and has a series of artificial drainage ditches on it.

Saxa Vord Study Area

The centre of the Saxa Vord Study Area is situated at approximate OS Grid reference HP643134, at the Saxa Vord Resort, south of the village of Norwick in northeast Unst (Appendix 7.2 Drawing 2).

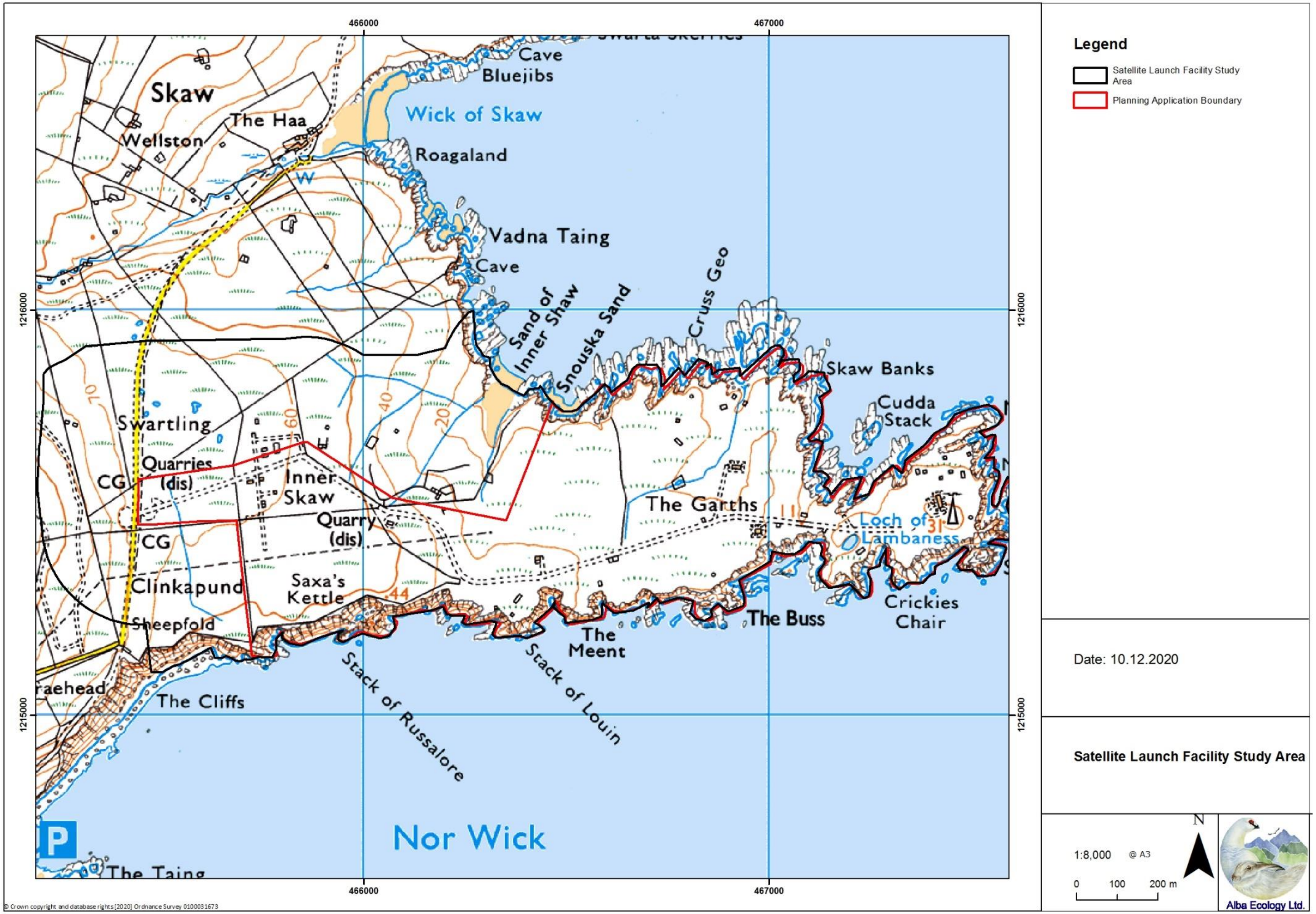
The Saxa Vord Study Area comprised of the proposed Application Boundary, plus a 100m buffer. Due to changes in design iteration in late 2020 the Application Boundary included an additional location at the current distillery, this was given a 100m buffer and had been surveyed in July 2018. This gives an area of 17.4ha (0.17km^2). A location map can be seen in Appendix 7.2 Drawing 2 with this Saxa Vord Study Area indicated with a pink outline.

The term 'Saxa Vord Resort' is used in this report to describe the buildings at the centre of the Saxa Vord Study Area including the restaurant, youth hostel and other accommodation. The Saxa Vord Study Area also includes the distillery building, roads, amenity grassland and sheep grazed fields.

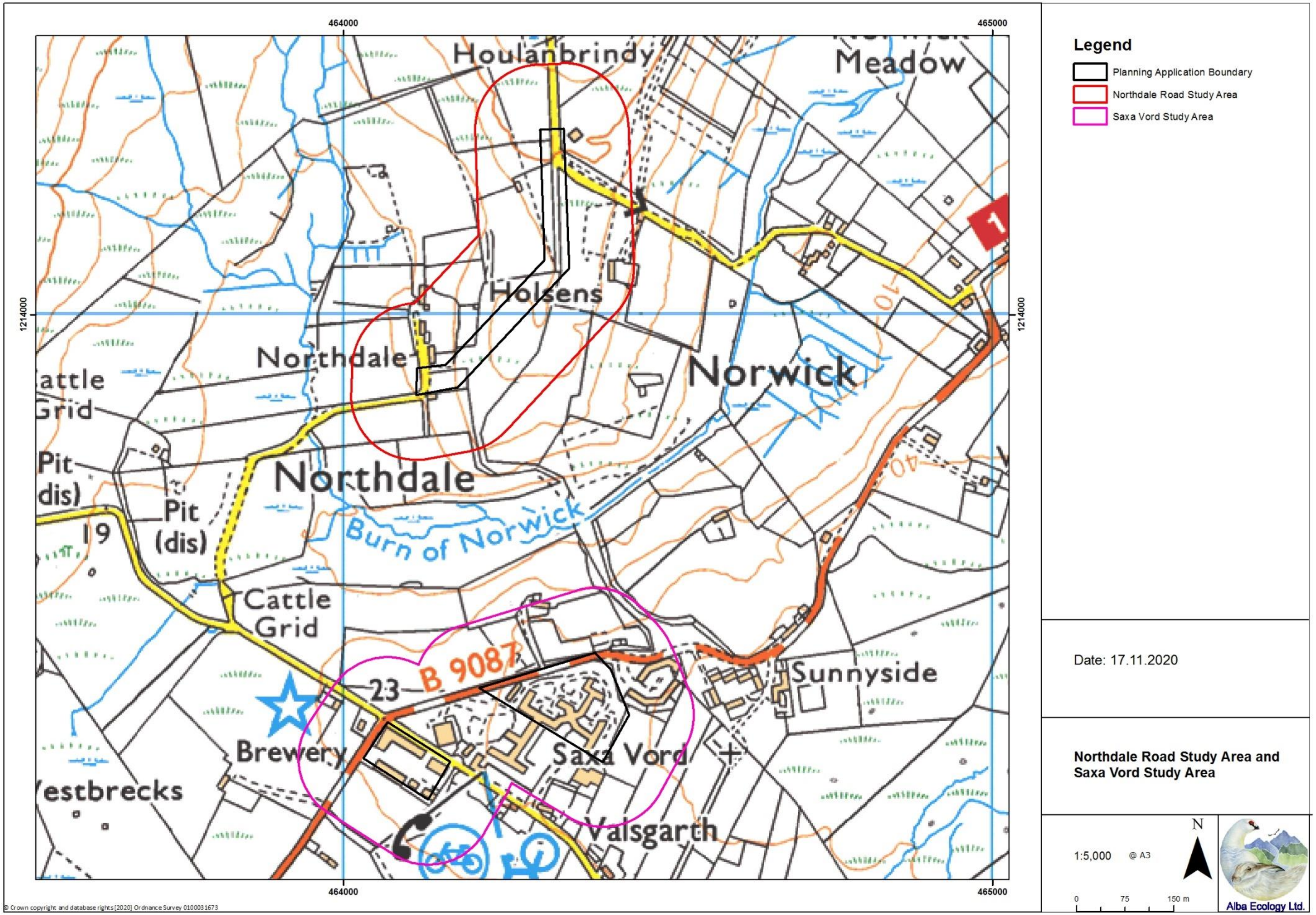
Northdale Road Study Area

A short section of connecting road is required between Northdale and Houlanbrindy. This Northdale Road Study Area is situated at approximate OS Grid reference HP643140, west of the village of Norwick in northeast Unst (Appendix 7.2 Drawing 2). The Northdale Road Study Area was comprised of the proposed Application Boundary, plus a 100m buffer which gives an area of 16.0ha (0.16km^2). A location map can be seen in Appendix 7.2 Drawing 2 with this Northdale Road Study Area indicated with a purple outline.

The Northdale Road Study Area includes sections of roads at Northdale and Houlanbrindy and the surrounding vegetation which was mostly sheep grazed grassland and dry dwarf shrub heath.



Appendix 7.2 Drawing 1: Satellite Launch Facility Study Area



Appendix 7.2 Drawing 2: Saxa Vord Study Area and Northdale Road Study Area

Considerations of Rare Plants

The geological and climatic extremes and isolation of Shetland have resulted in the islands having a wide range of vascular plants including at least 23 endemic species and a large number of rare and scarce species (Scott *et al.,* 2002). A notable botanical feature on Unst is the presence of some of these rare and endemic plant species. For example, the Keen of Hamar SSSI and SAC are designated for Shetland mouse-ear/Edmondston's chickweed; (*Cerastium nigrescens*); nationally rare Scottish sandwort (*Arenaria norvegica ssp. Norvegica*) and nationally scarce northern rock-cress (*Arabis petraea*) (NatureScot, 2020).

During initial Pre-application correspondence with SNH, Alba Ecology suggested conducting a rare/endemic species survey of the initial Application Boundary (a larger area than is considered in this report, including the new road at Northdale, Saxa Vord Resort, a Satellite Launch Facility at Lamba Ness and also area an around Unst airport). Johnathan Swale of SNH responded on 16/02/2018. In his correspondence he recommended that a rare species survey should be limited to the area around Unst airport due to the ultrabasic "serpentine" bedrock that occurs at that location. This area was subsequently dropped from the Application Boundary and so a rare/endemic plant species survey is not included within this report, although a watching brief for rare/endemic plant species was kept during Phase 1 Habitat and NVC surveys.

Soil and Geology

Soil and geological information can provide insight into the vegetation expected in the Study Areas and can inform decisions regarding Phase 1 Habitats categories and GWDTEs (McMullan, 2020). Therefore, the British Geological Society's (BGS) hydrogeological and geological mapping and the Scotland's Soils (2017) carbon and peatlands maps have been consulted to inform this survey report.

The carbon and peatland map describes the area of Lamba Ness and The Garths as having peaty soils with no peaty vegetation (Category 5 soils). It describes a small section of the northwest of the Satellite Launch Facility Study Area as having peatland with peatland vegetation (Category 1). The rest of the Satellite Launch Facility Study Area, including Saxa's Kettle and Inner Skaw, towards Swartling is classed as predominantly mineral soils with some peaty soils. The vegetation for this area is described as heath with some peatland vegetation (Category 4; Scotland's Soils. 2017).

The BGS open mapping data describes the superficial deposits over the majority of the Satellite Launch Facility Study Area as "*till and Morainic deposits (undifferentiated) – Diamicton*" and provides information on these as such "*these sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods*" (BGS, 2020a). There were also some superficial deposits, within the centre the Satellite Launch Facility Study Area, near Inner Skaw, described as 'Blown Sands' with further information describing the soil in this area as "*These sedimentary deposits are aeolian in origin. They are detrital, comprising medium- to fine- grained materials, forming lenses, beds (and locally) dunes*" (BGS, 2020a).

Site specific Surveys in 2020 demonstrated that there was peaty soils and deep peat within the Satellite Launch Facility Study Area (Appendix 12.3).

The bedrock for the majority of the Satellite Launch Facility Study Area is described by the BGS as the "*Skaw Intrusion - Microgranite, Porphyritic. Igneous Bedrock formed approximately 359 to 444 million years ago in the Devonian and Silurian Periods*". It goes on to describe these as "*These igneous rocks are magmatic (intrusive) in origin. Rich in silica, they form intruded batholiths, plutons, dykes and sills*" (BGS, 2020a). The hydrogeological maps describe this bedrock as a "*low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*" (BGS, 2020b).

There is a change in the geology, which coincides with the road running north to south in the far west of the Satellite Launch Facility Study Area. To the west of the road the bedrock is described as "*Hevda Phyllite Formation - Pelite, Phyllitic. Metamorphic bedrock formed approximately 541 to 1000 million years ago in the Period. Originally sedimentary rocks. Later altered by low-grade metamorphism*" (BGS, 2020a). The hydrogeological maps described this bedrock as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b).

Details regarding the soils, bedrock, and hydrogeology at the Saxa Vord Study Area and the Northdale Road Study Area are shown in Table 1.

	Saxa Vord Study Area	Northdale Road Study Area
Carbon and peatland maps	Peaty soils with no peatland vegetation (Category 5)	Mineral soils with no peaty vegetation (Category 0)
BGS – superficial deposits	Till and Morainic Deposits (undifferentiated) - Diamicton. Superficial Deposits formed up to 3 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions. These sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.	Till and Morainic Deposits (undifferentiated) - Diamicton. Superficial Deposits formed up to 3 million years ago in the Quaternary Period. Local environment previously dominated by ice age conditions. These sedimentary deposits are glacigenic in origin. They are detrital, created by the action of ice and meltwater, they can form a wide range of deposits and geomorphologies associated with glacial and inter-glacial periods during the Quaternary.
BGS – bedrock	Gruting Greenschist Formation - Metalava and Metatuff. Metamorphic Bedrock formed approximately 419 to 485 million years ago in the Silurian and Ordovician Periods. Originally igneous rocks formed by eruptions of magma. Later altered by low-grade metamorphism. Setting: Originally igneous rocks formed by eruptions of magma. These rocks were igneous in origin, possibly formed as volcanic (extrusive) flows of lava but have subsequently undergone metamorphism.	Norwick Phyllite Formation - Pelite, Phyllitic. Metamorphic Bedrock formed approximately 419 to 485 million years ago in the Silurian and Ordovician Periods. Originally sedimentary rocks formed in shallow seas. Later altered by low-grade metamorphism. Setting: Originally sedimentary rocks formed in shallow seas. These rocks were sedimentary in origin, possibly shallow-marine (siliciclastic units), but have subsequently undergone metamorphism.
BGS - hydrogeological maps	Low productivity aquifer with small amounts of groundwater in near surface weathered zone and secondary fractures.	Low productivity aquifer with small amounts of groundwater in near surface weathered zone and secondary fractures.

Table 1: Summary descriptions of the soils, bedrock, and hydrogeology at the Saxa Vord Study Area and the Northdale Road Study Area (BGS, 2020a; BGS, 2020b; Scotland's Soils, 2017)

Methods

The vegetation surveys were conducted using 1:25,000 Ordnance Survey maps and aerial photographs with a resolution of 25cm that were taken in June 2016 purchased from emapsite. The Phase 1 Habitat survey and the NVC survey were conducted at a scale of 1:2,500 for the Satellite Launch Facility and Saxa Vord Study Area and 1:5,000 for the Northdale Road Study Area using the Ordnance Survey maps and aerial photographs.

Habitat Surveys

Two standard methodologies were used to survey the vegetation within the three Study Areas: the Phase 1 Habitat survey (JNCC, 2010; revised 2016 and JNCC, 2012) and the NVC (Rodwell, 2006). Phase 1 Habitat surveys are a standard national classification scheme of broad habitat types and are based on plant species presence and some abiotic indicators such as soil type. The NVC is a more detailed survey of plant communities using plant species abundance as well as presence and often using quadrat data. More than one NVC community may be present within a single Phase 1 Habitat category, and visa-versa. GWDTE were determined from the NVC survey results and from the Functional Wetland Typology (FWT) guidance (SNIFFER, 2009a). The FWT was designed to enable a basic identification of wetland habitats in Scotland and Northern Ireland using landscape features and field indicators. The FWT data and NVC communities were compared with the published table to assess whether wetlands were potential GWDTE (SEPA, 2017).

Some of the habitats within the Study Areas were identified as peatlands. Therefore, the Peatland Condition Assessment (PCA) was consulted during the surveys and consideration given to the condition of the peatland based on this guide (Peatland Action, 2016). CIEEM provide no specific guidance on use of PCA in EcIA but given both the advisory and regulatory roles NatureScot (formerly SNH) have, PCA is considered a guidance support tool and is used as such.

The surveys that were conducted at and around Saxa Vord Study Area and the Northdale Road Study Area were completed from publicly accessible roads and viewpoints. The surveyors did not enter any of the gardens or fields to complete the survey as public access was not clear or assumed.

Phase 1 Habitat Survey

A Phase 1 Habitat survey was conducted by Dr Kate Massey and Dr Fergus Massey of Alba Ecology Ltd. in July 2018. The vegetation was described and mapped following the methods described in the Joint Nature Conservation Committee (JNCC) Handbook for Phase 1 Habitat surveys (JNCC, 2010; revised 2016, and JNCC, 2012).

All three Study Areas were walked at a slow pace to accurately map all the habitats present. Plant species were identified and habitat types assigned and mapped in the field. The Phase 1 Habitat survey was extended to include plant species lists for each habitat type and an assessment of each species' overall abundance using the DAFOR scale (Dominant, Abundant, Frequent, Occasional and Rare). The smallest habitat size mapped was approximately 10m×10m. For smaller features, target notes were made, including a 10-digit grid reference taken using a hand-held Garmin geographical positioning system (GPS) unit.

In July 2020, the three Study Areas were revisited by Dr Kate Massey, as per best practice guidance (CIEEM, 2019). The habitats were considered for any changes since the 2018 field surveys, and any updates made as necessary.

National Vegetation Classification (NVC) Survey

An NVC survey was conducted in July 2018 by Dr Kate Massey and Dr Fergus Massey of Alba Ecology Ltd. The vegetation was classified and mapped following the methods described in the JNCC National Vegetation Classification User's Handbook (JNCC, 2006).

All three Study Areas were walked at a slow pace, ensuring comprehensive coverage to accurately describe and map all communities and sub-communities. Each NVC community and sub-community type was assigned in the field by an experienced surveyor with the use of NVC field guides (e.g. Elkington *et al.*, 2001; Cooper, 1997). These data were subsequently compared with the published NVC communities using the definitions and the floristic tables (Rodwell, 1991; Rodwell, 1992; Rodwell, 1995; Rodwell, 2001; Averis *et al.*, 2004; Dargie, 1998a).

Quadrat data were taken where deemed appropriate particularly if, in the surveyor's professional judgment, the vegetation did not obviously fall into an existing published NVC community, or combination of communities. Standard NVC methodology does not require quadrats to be taken in each stand of vegetation (Rodwell, 2006). Where quadrat data was taken, the quadrats were 2×2m in size. All higher plants and common mosses were identified and their percentage cover assessed. The data was tabulated into consistency tables and compared to the published NVC communities using the keys and the floristic tables (Rodwell, 1991; Rodwell, 1992; Rodwell, 1995; Rodwell, 2001). In addition, the new version of TABLEFIT (Marrs *et al.,* 2020) was used for comparison. TABLEFIT calculates the top five community types that the data fits and provides a co-efficient of best-fit. The NVC community was then judged by comparing the results of these two approaches and using the author's professional experience and judgment.

The minimum size of vegetation mapped was approximately 10m×10m. Smaller stands were described as target notes, located with 10-digit grid reference using a GPS. Target notes were also made of any unusual features, rare species, management activities or other points of particular interest.

In July 2020 the three Study Areas were revisited by Dr Kate Massey, as per best practice guidance (CIEEM, 2019). The communities were considered for any changes since the 2018 field surveys, and any updates made as necessary.

Groundwater Dependant Terrestrial Ecosystems (GWDTE)

Wetland habitats were identified in the field using the FWT (SNIFFER, 2009a and 2009b). Where a wetland was noted, a grid reference, and target note was made and sample photographs were taken. SNIFFER (2009a) cross-mapped the wetland typology with Phase 1 Habitats and NVC vegetation types to allow comparison. Therefore, the Phase 1 and NVC communities were used to inform wetlands categorisation. Where wetlands were identified, an assessment was made as to whether they were potentially GWDTEs as defined in SEPA Guidance Note LUPS-GU31 Version 3 (SEPA, 2017).

Peatland Condition Assessment (PCA)

As some of the habitats within the three Study Areas were classed as peatlands, the Peatland Condition Assessment (PCA) was consulted. PCA bases the condition of peatlands on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). The PCA recognises four broad categories of peatland condition:

1. Near natural - peat forming bog-mosses dominant, with no recent fires, little or no grazing pressure and little or no bare peat, heather is not dominant.

2. Modified – bare peat is in small patches, fires may be recent, grazing impacts are evident, bog-mosses are absent or rare, extensive cover of heather or purple moor-grass.
3. Drained – within 30m either side of an artificial drain or a revegetated hagg or gully system.
4. Actively eroding – actively eroding hagg/gully system, extensive continuous bare peat surfaces.

At least one category from the PCA was assigned to each area mapped as the Phase 1 Habitat category 'bog'.

The PCA Support Tool also gives descriptions of peatlands as being in 'good, intermediate or bad condition' (Glenk *et al*., 2017). The criteria for these are shown in Table 2.

Signs	**Good condition**	**Intermediate condition**	**Bad condition**
Water	Plenty of water, visible on the surface	Surface water is rarely visible	Deep gullies have formed from wind and water erosion
Vegetation	Small grasses, bog-mosses (*Sphagnum spp.*) common and very wet	Taller plants, such as cottongrasses (*Eriophorum spp.*) and heather	Rarely any plants grow on the areas that are exposed. Patches of grasses or heather are still found on 'islands' in between exposed bare peat
Bare peat	Little to no bare peat patches	Bare peat patches are occasional, burning may occur	Bare peat areas will continue to expand, leaving less plant cover as protection on the surface. Peat will continue to be lost until the solid rock is exposed
Water quality	Water flowing from good quality peatland is clear	Water flowing from peatland likely to be slightly brown, especially after heavy rainfall	Bad quality, it can be dark brown from the peat content
Wildlife	Good for wildlife	Wildlife less abundant than in good condition	Home to little wildlife
Resultant activity level	Active	Stopped growing, inactive	Inactive

Table 2: Peatland Condition Assessment Support Tool categories of good, intermediate and bad peatland (Glenk et al., 2017).

Nomenclature

Both common and binomial scientific names are given the first time a species is mentioned within this report. Thereafter, common names only are used. Nomenclature follows Streeter (2016) for higher plant species, and Atherton *et al*., (2010) for bryophyte species.

Habitat and Species Evaluation

Evaluation of the species and habitats identified during the survey was completed using the best practice guidance (CIEEM, 2018). This considered a number of facets, including (but not necessarily limited to):

- Naturalness.
- Animal or plant species, sub-species or varieties that are rare or uncommon, either internationally, nationally or more locally, including those that may be seasonally transient.
- Ecosystems and their component parts, which provide the habitats required by important species, populations and/or assemblages.
- Endemic species or locally distinct sub-populations of a species.
- Habitats that are rare or uncommon.
- Habitats that are effectively irreplaceable.
- Habitat diversity.
- Size of habitat or species population.
- Habitat connectivity and/or synergistic associations.
- Habitats and species in decline.
- Rich assemblages of plants and animals.
- Large populations of species or concentrations of species considered uncommon or threatened in a wider context.
- Plant communities (and their associated animals) that are considered to be typical of valued natural/semi-natural vegetation types, including examples of naturally species-poor communities.
- Species or habitats on the edge of their range, particularly where their distribution is changing as a result of global trends and climate change.
- Geographical context (range/abundance when considered against known extent at various levels, local, regional, national etc.).
- Rarity listing and legal protection status.
- Presence on the Scottish Biodiversity Lists (SBL)
- Annex 1 habitat and species lists.

The SBL is a list of animals, plants and habitats that Scottish Ministers consider to be of principal importance for biodiversity conservation in Scotland under the Nature Conservation (Scotland) Act 2004 (NatureScot, 2020). The UK BAP list of species and habitats has been superseded by the SBL (CIEEM, 2017). However, the classification system used for habitats within the SBL is the UK BAP priority habitats (Scottish Government, 2013). Therefore, UK BAP habitat descriptions are referred to within the habitat evaluation sections of this report.

For the avoidance of doubt, CIEEM EcIA guidance (2018) makes it clear that species and habitats which appear on national lists e.g. Schedule 1 of the Wildlife and Countryside Act (1981 as amended) are not necessarily evaluated as nationally important simply by appearing on such a list. Importance evaluation must consider the number of individuals of species within a geographical context/scale, i.e. how many of a particular species are likely to be affected by the Proposed Development and what proportion of the local/regional/national population does this constitute. Legal listing/protection is a separate but important consideration.

Habitat categories and the 'condition' of these categories are human (or artificial) constructs and, therefore, to a degree are subjective and a matter of professional judgement. Furthermore, different conditions can co-exist in an area of habitat (e.g. through drainage, preferential grazing, trampling etc.) and so it is not appropriate to assume an entire area of habitat is in one condition or another. Under these circumstances, it is usually reported that the habitat is approaching a particular condition. This is fully recognised in Phase 1 Habitat and NVC assessments and consequently it is not always possible to be unequivocal when making judgements such as whether a particular habitat is classified under one condition or another. Where these have occurred with vegetation communities, they have been noted and explained.

Limitations

Standard sampling methods were followed, and any biases or limitations associated with these methods could potentially affect the results collected. Furthermore, while every effort was made to provide a full assessment and comprehensive description of the three Study Areas, it is unlikely that one survey can achieve full characterisation due to variations that occur with time. This survey report should be considered as a snapshot in time, specifically July 2018 and July 2020.

As with all Phase 1 Habitat and NVC surveys, the intention of the survey work was not to create a full inventory of the botanical species in the three Study Areas, but to map and describe the habitats and communities present. Species were recorded when they were encountered, but it is likely that additional species, not listed, are present within the Study Areas, particular as species presence and visibility varies throughout the growing season. Additionally, some of the habitats within the Study Areas, particularly within the Satellite Launch Facility Study Area, were particularly heavily grazed by sheep rendering some plant identification more challenging. In these instances, professional judgement was applied. These are recognised limitations common to all Phase 1 Habitat and NVC surveys but were minimised by conducting the survey within the optimal survey period during two different growing seasons.

Similarly, the walkover surveys are not intended to count all individuals of any particular species. When a count of a particular species is mentioned within the report or target notes, it is visual estimate only, based on what was easily seen at the time of survey. Where precise locations are provided for a particular species, it is to provide an example location. It is highly unlikely that every individual, of any species, was located during the walkover survey.

Plant species occurrence and visibility change both temporally and spatially. This is particularly true for colonising and invasive species. The data provided by habitat surveys is a snapshot in time (specifically July 2018 and July 2020 for this survey) and cannot account for changes that occur outwith this time period. Non-native invasive species can be prolific colonisers. For example, Japanese knotweed (*Fallopia japonica*) spreads from rhizomes, rhizome fragments, as well as stem and crown fragments. Spread is usually a result of human intervention, such as spreading fragments in tyre treads (Fennell *et al.,* 2018). Additionally, at different times of year (e.g. winter) or life-stage (e.g. early colonisation) the identification of non-native invasive species can be challenging. Therefore, although non-native invasive species were considered during field surveys and field surveys were conducted at the optimal time of year, it is possible for non-native invasive species to be present within the Study Areas.

The Phase 1 Habitat, NVC and GWDTE maps are only indicative of the habitat boundaries of the Study Areas. It is challenging to map the area to a higher degree of accuracy because there is often no clear boundary between vegetation types, there being instead a gradual gradation. Also, many of the NVC communities in the Study Areas contained a similar assemblage of species and were often at a transitional stage between two community types. This is a recognised limitation of all vegetation mapping. Surveying in Scotland as a whole, and even more so for Shetland, has the added limitation that the NVC community descriptions were often derived from work carried out in England. Therefore, the fit of the communities to the published accounts are often imperfect and the closest approximation of the communities is described.

Estimating peat depth can be an important component for determining some Phase 1 Habitat types and FWT types. However, it is important to note that measuring peat depth was outside the scope of these vegetation surveys. Apparent peat depth as discussed in this report is estimated based on visual assessments only.

Results – Satellite Launch Facility Study Area

The Phase 1 Habitat survey map for the Satellite Launch Facility Study Area is shown in Appendix 7.2 Drawing 3 and a list of habitat types are displayed in Table 3. The NVC survey map of the Satellite Launch Facility Study Area is shown in Appendix 7.2 Drawing 4 with the potential GWDTE and PCA maps in Appendix 7.2 Drawing 5 and 6 respectively[1]. These drawings are supported with list a of target notes (Annex 1, Appendix 7.2 Drawing 7). Photographs of the habitats and interesting features are shown in Annex 2.

Overview

The Satellite Launch Facility Study Area included distinctive maritime grassland in the east, on Lamba Ness, which had a range of pools and damp grassland. This transitioned into an area of wet modified bog dominated by purple moor-grass (*Molinia caerulea*). More westerly in the Satellite Launch Facility Study Area the habitats were made up of wet modified bog/wet heath habitat, which was dominated by heather (*Calluna vulgaris*) and common cottongrass (*Eriophorum angustifolium*). The most westward side of the Satellite Launch Facility Study Area transitioned into blanket bog habitats.

There were small areas of other habitats, including standing water, marginal vegetation at the edge of pools and saltmarsh perched within the coastal vegetation. The old military buildings and roads and other infrastructure were also mapped across the Satellite Launch Facility Study Area and often had distinct vegetation around them, enriched from the sheep that sheltered in them.

All the habitats within the Satellite Launch Facility Study Area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. Sheep were evident across the Satellite Launch Facility Study Area and the impacts of fertilisation, grazing and sheep lay-down areas were recorded. Drainage ditches, both very recently cut, and older, were also recorded in the wet modified bog and wet modified bog/wet heath habitats. There were areas of naturally occurring haggs, within the blanket bog, which were likely to be exacerbated by sheep.

[1] Drawings are provided within this report document for ease of reference, but higher resolution versions are provided separately as PDFs.

Phase 1 Habitats	**Area (ha)**	**% of Satellite Launch Facility Study Area**
Wet modified bog/wet heath	30.5	26.1
Wet modified bog	28.2	24.2
Coastal grassland	19.7	16.8
Semi-improved acid grassland	16.3	14.0
Unimproved acid grassland	7.3	6.2
Wet modified bog/wet heath/dry heath	6.5	5.6
Buildings and roads	1.8	1.5
Fen	1.5	1.3
Blanket bog/bare peat	1.5	1.3
Blanket bog	1.1	1.0
Dry dwarf shrub heath	0.7	0.6
Saltmarsh	0.4	0.3
Wet modified bog/wet heath/bare peat	0.3	0.2
Sand dunes	0.3	0.2
Marginal and inundation	0.2	0.2
Wet modified bog/wet heath/acid flush	0.2	0.2
Bare ground	0.1	<0.1
Acid flush	0.1	<0.1
Bare peat	0.1	<0.1
Neutral grassland	0.1	<0.1
Standing water	<0.1	<0.1
Open vegetation	Too small to map separately	N/A
Water courses and drains	Mapped as lines	N/A
Total	***116.9***	***100.0***

*Table 3**:** The area of each of the Phase 1 Habitats found in the Satellite Launch Facility Study Area.*

Habitat and Community Descriptions

The habitats and communities that were found within the three Study Areas are described in the following manner: firstly a Phase 1 Habitat description, followed secondly by the corresponding NVC community(ies) and finally a comment on the FWT category and potential groundwater dependency where relevant.

Coastal grassland

Coastal grassland was mapped for much of the cliff tops of Lamba Ness and The Garths in the east of the Satellite Launch Facility Study Area. The coastal grasslands were dominated by red fescue (*Festuca rubra*) with a variety of maritime species such as thrift (*Armeria maritima*), maritime plantain (*Plantago maritima*) and buck's-horn plantain (*Plantago coronopus*).

Lamba Ness was a military base during WWII and the associated abandoned infrastructure was evident across the peninsula. However, the main landuse at the time of surveying was sheep grazing which was evident and influential in the coastal grassland habitat. Many of the military buildings were used as shelter by the livestock resulting in localised fertilisation.

The coastal grassland was short (3-10cm) and tightly entwined, with cushions of thrift and mats of plantains. They were wind swept and had dung and fleece evident from the sheep. There were areas where sheep laydown and used as shelter within the coastal grassland. These areas often showed signs of localised enrichment. Some areas, where sheep clearly found shelter, the soil profile was revealed showing a thin richer (peaty soil) layer, followed by sands and gravels.

There were four coastal NVC communities mapped and described.

MC8d *Festuca rubra – Holcus lanatus* maritime grassland, *Holcus lanatus* sub-community

The MC8d maritime grassland community was dominated by red fescue with thrift abundant and conspicuous in the sward. Yorkshire fog (*Holcus lanatus*) was variable in cover, but generally quite abundant. It was a closed, thick, low sward of approximately 5-10cm on what appeared to be shallow peaty soil over sand. This community showed signs of extensive grazing by sheep.

There were a variety of species that were common throughout the sward including abundant white clover (*Trifolium repens*), creeping buttercup *(Ranunculus repens*) and maritime plantain along with the appearance of species such as ribwort plantain (*Plantago lanceolata*) and common bent (*Agrostis capillaris*).

Less abundant forbs included red clover (*Trifolium pratense*), daisy (*Bellis perennis*), ragged robin (*Lychnis flos-cuculi*), bird's-foot trefoil (*Lotus corniculatus*), squill (*Scilla spp.*) and common mouse-ear (*Cerastium fontanum*).

Other graminoids present at lower abundances included smooth meadow-grass (*Poa pratensis*), mat grass (*Nardus stricta*), sheep's fescue (*Festuca ovina*) and sweet vernal grass (*Anthoxanthum odoratum*). In wetter patches sedges became more apparent including carnation sedge (*Carex panacea*) and common sedge (*Carex nigra*).

In patches where the sheep lay in hollows, within the MC8d grassland, there were small patches of sheep's fescue with common chickweed (*Stellaria media*). These areas were too small to map separately, although some were target noted.

MC10a *Festuca rubra - Plantago spp*. maritime grassland, *Armeria maritima* sub-community

The red fescue – plantain grassland, thrift sub-community, MC10a, was described most extensively on the point of Lamba Ness. The grassland was generally less species rich than the other coastal grassland communities. It was close cropped by sheep grazing. Sea plantain was dominant, with thrift, red fescue, and some ribwort and buck's-horn plantain all abundant and constant in the sward. No other species had any prominence on these sea cliff grasslands, although there was a little autumn hawkbit (*Scorzoneroides autumnalis*), bird's-foot trefoil, sheep's fescue, sweet vernal grass and creeping buttercup.

There were small areas of MC10a grassland on the banks of some military buildings. Red fescues, plantains and thrift were all abundant, but there were a variety of other grasses including sheep's fescue, wavy hair-grass (*Deschampsia flexuosa*), Yorkshire fog and sweet vernal grass. There was also a little common bent and creeping bent (*Agrostis stolonifera)*. There was frequent creeping buttercup and white clover with occasional mouse ear, heath bedstraw (*Galium saxatile*), and daisy in these areas.

MC10b *Festuca rubra - Plantago spp*. maritime grassland, *Carex panacea* sub-community

The red fescue – plantain grassland was commonly found on the seaward facing slopes of Lamba Ness. The grassland was generally close cropped by sheep grazing. Red fescue was abundant along with sheep's fescue and mat grass. The plantain species, including maritime, ribwort and buck's-horn were all very common and constant in the sward. Thrift was apparent and abundant as were some of the sedge species, particularly carnation sedge, but also common sedge and sometime common yellow sedge (*Carex viridula ssp. oedocarpa*). In some stands of this grassland common sedge was the dominant species. Other forb species present included bird's-foot trefoil, autumn hawkbit, ragged robin, eyebright and creeping buttercup. In wetter patches lesser spearwort (*Ranunculus flammula*) was seen.

Graminoids that were recorded at lower frequencies included smooth meadow-grass, Yorkshire fog and jointed-rush (*Juncus articulatus*).

MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community

MG11 is a community which is associated with improved vegetation with coastal influences. Due to the cliff top location and clear maritime influence the MC11 grassland has been included in the coastal grassland category, as per the Saltmarsh Survey of Scotland, rather than as a saltmarsh where it is often included (Haynes, 2016). The MG11 community appeared to best describe some of the very small (often <5m wide) bright green grasslands around the old military buildings on Lamba Ness where sheep sheltered and grazed heavily and so enriched the vegetation.

Red fescue, creeping bent and Yorkshire fog were the most abundant grasses, although some stands had a high abundance of perennial rye grass (*Lolium perenne*). These areas have obvious associations with the MG11a sub-community and also included white clover and creeping buttercup. Other grasses in the MG11 community included smooth meadow-grass, Yorkshire fog, and sheep's fescue, but these were generally all at low abundances.

Silverweed (*Potentilla anserina*) was abundant in most stands, but had a more occasional presents, or absence in other stands. There were patches in some stands where common chickweed was abundant to dominant. Thrift, plantains, sheep's sorrel and autumn hawkbit were all present in low frequencies.

The MG11 community was closely cropped, but there were occasional taller patches of soft rush (*Juncus effusus*), nettles (*Urtica dioica*) and marsh thistle (*Cirsium palustre*) and rarely spear thistle (*Cirsium vulgare*).

Wet grassland

The coastal grasslands MC8 and MC10 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE. MG11 is considered to be a wet grassland in the FWT and is listed as potentially moderately GWDTE depending on the hydrological setting by SEPA guidance.

Saltmarsh

There were several very small areas of perched saltmarsh recorded on the cliff tops of Lamba Ness. Perched saltmarshes can form on sea cliffs where shallow sediment develops in the wave splash-zone or from sea spray (Haynes, 2016). There was one saltmarsh NVC community recorded which was dominated by saltmarsh rush.

The Scottish Saltmarsh Survey recorded the most northerly saltmarsh in the UK in Baltasound (ca. 6km south of the Satellite Launch Facility Study Area (Haynes, 2016)). However, the very small perched saltmarsh communities found in the Satellite Launch Facility Study Area were likely smaller than the smallest mappable unit considered in the large scale Saltmarsh Survey of Scotland (Haynes, 2016).

SM16b *Festuca rubra* salt-marsh community, *Juncus gerardii* dominant sub-community

There were several small peaty channels on Lamba Ness which were dry at the time of the survey but clearly had periods where they were inundated and impacted by sea spray. They were ca. 2-3m wide and likely to be old ditch channels. These areas were dominated by saltmarsh rush, sometimes overwhelmingly so. These areas were mapped as SM16b which is one of the few sub-communities found on perched sites where thin layers of sediment develop in the sea splash zone (Haynes, 2016).

The other constant species in the SM16b community were red fescue and sea plantain with additionally species being more patchily distributed. In one stand, lesser spearwort was conspicuous with common sedge and carnation sedge abundant. Other species recorded were sweet vernal grass, eyebright and jointed rush.

There was a very small patch (ca. 6m×3m) of a seepage line in which sea arrowgrass (*Triglochin maritimum*) was the most notable species. There was also thrift, red fescue and sea plantain. There may have been association with the perched saltmarsh community SM19 although, given the very limited size and the proximity to the SM16 community it has been included as part of the SM16.

Saltmarsh is included as a wetland within the FWT. However, SM16 and SM19 are not listed as potentially GWDTEs by SEPA guidance (SEPA, 2017).

Sand dunes

There was a small area of sand dune, including open dune and dune grassland vegetation, at a small inlet at Inner Skaw, in the north of the Satellite Launch Facility Study Area. There was an accumulation of bare sand in the inlet which formed a small beach. There was ca. 20m wide, stretch of open dune (SD4), followed by a ca. 20m wide stretch of dune grassland (SD8d), although they transitioned into one another. Inner Skaw formed part of the Shetland report of the Sand Dune Vegetation Survey of Scotland (SDVSS, Dargie, 1998a, 1998b, 1998c). The mapping and descriptions from the 1998 SDVSS coincide closely with this report, although, the NVC data are not identical. This would be expected as the surveys were conducted in different years and likely at different times of year. There would also variation in the surveyor's use of the NVC and their professional judgement. This between surveyor variation is a well-known and understood limitation to NVC surveying (e.g. Hearn *et al.* 2011).

SD4 *Elytrigia juncea* fore-dune community

The SD4 vegetation fore-dune was sparsely vegetated on wind-blown bare sand. It was made up of sand couch (*Elytrigia juncea*), with occasional lyme grass (*Leymus arenarius*) with a little ribwort plantain and sea sandwort (*Honckenya peploides*). Oysterplant (*Mertensia maritima*) was occasional in this community. This is consistent with the descriptions of SD4 within the Shetland report of the SDVSS where it describes sand couch as the only consistent species in SD4 in Shetland, and that it is a species poor community (Dargie, 1998a).

SD8d *Festuca rubra – Galium verum* fixed dune grassland *Bellis perennis - Ranunculus acris* sub-community

The SD8d vegetation was more species rich and made up a higher proportion of the ground cover than the SD4, although there were still areas where there was 20-30% bare sand. It was a narrow section of dune grassland which had influences from both the maritime grassland and the fore-dune vegetation. Red fescue was the most common species, with ribwort plantain abundant. Daisy, white clover, creeping buttercup were constant but with low frequencies. Eyebright (*Euphrasia spp.*) and mouse-ear were more rarely seen. Species associated with the maritime grassland communities were more common on the landward side, such as thrift and sea plantain. Lyme grass and sand couch were more frequent as it transitioned into the fore-dune.

SD8d is reportedly the most common of the SD8 grasslands in Shetland and was considered to be generally species poor (Dargie, 1998a).

The sand dune communities SD4 and SD8 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE.

Semi-improved acid grassland

The semi-improved acid grassland was found in the more inland areas of the Satellite Launch Facility Study Area in areas around Inner Skaw and Skaw. It was mapped in several large fields and some smaller areas beside buildings, road verges, tracks and old borrow pits.

The semi-improved acid grassland habitat was sheep grazed and likely to be on shallow peaty soils. It often formed part of a mosaic with other grassland types or wet modified bog/wet heath, although it usually made up the largest portion of the habitat mosaic present.

One semi-improved acid grassland NVC community type was described, U4b, although this was split into two types. One type was more improved than the other, evidenced by the high proportion of perennial rye grass.

U4b *Festuca ovina – Agrostis capillaris – Galium saxatile* grassland, *Holcus lanatus – Trifolium repens* sub-community

The U4b grassland was usually highly grazed, to 2-3cm, although it could have a rougher appearance with taller tussocks of less palatable species.

There was a mixture of abundant grasses, particularly red fescue, sheep's-fescue, common bent and Yorkshire fog. Other grasses were present at low abundances including smooth meadow-grass, sweet vernal grass, brown bent (*Agrostis vinealis*) and creeping bent. The grassland was forb rich, although most of these forbs were patchily distributed in the grassland, with none having a high prominence except perhaps white clover and ribwort plantain. Other forbs present included yarrow (*Achillea millefolium*), eyebright, sheep's sorrel (*Rumex acetosella*), creeping buttercup, spring squill (*Scilla verna*), dandelion (*Taraxacum agg*.), autumn hawkbit, selfheal (*Prunella vulgaris*), St. John's wort (*Hypericum spp.*) and heath spotted orchid (*Dactylorhiza maculata*) to name but a few. Where U4b was found in borrow pits and there were exposed rocks there was occasionally some thyme (*Thymus polytrichus*) present.

Some stands of U4b grassland had a high portion of perennial rye grass and showed signs of improvement. In these stands daisy and white clover tended to have a high-very high abundance. These stands had affinity to MG7, although, the species richness, and other grasses, particularly fescues and bent-grasses, placed it into the U4b community. To distinguish this more improved U4b type from the less improved U4b grassland it was mapped as U4b (MG7).

The semi-improved acid grassland U4 is not included in the FWT and is not a GWDTE.

Unimproved acid grassland

The unimproved acid grassland was generally recorded on the lower slopes of the hill side, and as part of the dry dwarf shrub heath mosaic.

Unimproved acid grasslands are generally unenclosed hill-grazed land and are relatively species poor (JNCC, 2010 revised 2016). The unimproved acid grassland within the Satellite Launch Facility Study Area was generally dominated by either mat grass or heath rush (*Juncus squarrosus*). Heath bedstraw was the most common forb species. Grazing by sheep was apparent.

A total of three unimproved acid grassland NVC sub-communities were described in the Satellite Launch Facility Study Area.

U5a *Nardus stricta – Galium saxatile* grassland, species poor sub-community

The U5a acid grassland community was a rough grassland mainly found in small patches around The Garths. It was strongly dominated by mat grass with tormentil abundant and conspicuous in the vegetation. It included a variety of other grass species at low abundances such as Yorkshire fog, sweet vernal grass, common bent, red fescue, smooth meadow-grass and a little purple moor-grass. Forbs were restricted to selfheal, common dog violet (*Viola riviniana*) and rarely mouse ear and ragged robin.

There was a little heath wood-rush (*Luzula multiflora*) present. The moss layer was not well developed.

U5b *Nardus stricta – Galium saxatile* grassland, *Agrostis canina – Polytrichum commune* sub-community

The U5b grassland was well defined, with mat grass dominant, but not overwhelmingly so, and a variety of other grass had some prominence, including red fescue, sweet vernal grass and wavy hair-grass. Tormentil was the most abundant forb. There was occasional heath spotted orchid and eyebright. The moss layer was much more developed than the U5a sub-community with common haircap (*Polytrichum commune*), red bog-moss (*Sphagnum capillifolium*) and red-stemmed feather-moss (*Pleurozium schreberi*) all being present with varying abundances.

This community was found as a mosaic with the heath rush dominated grassland U6, particularly to the southwest of the Satellite Launch Facility Study Area, but also in small patches (sometimes too small to map). In these areas U5 was generally the most common grassland community, with U6 making up small patches.

U6 *Juncus squarrosus – Festuca ovina* grassland community

There were small patches of the U6 heath rush dominated grassland across the Satellite Launch Facility Study Area. Heath rush was dominant although mat grass could be very abundant in some stands, making it difficult to distinguish between U5 mat grass grassland and U6 heath rush grassland in some locations. However, where heath rush was considered to be dominant, and mat grass subordinate, it was assigned the U6 grassland category. There were also patches where heath rush dominated, but with purple moor-grass abundant. These were mapped as M25b, but the association with U6 was obvious.

The U6 grassland community was found in flushes and at transitions between grassland and heath and bog. It included heath bedstraw, but more frequently tormentil. There were a variety of other graminoids present including wavy hair-grass, sweet vernal grass and heath wood-rush which were occasional. Forbs that were seen, but only rarely, in the U6 grassland included sheep's-bit (*Jasione montana*) and sheep's sorrel.

The ground layer was usually dominated by common haircap, although there were hypnum mosses present too.

Montane grassland

Montane grasslands, as defined by the FWT, are wet areas of very short dense vegetation which may include some of the unimproved acid grassland Phase 1 Habitats and NVC communities (SNIFFER, 2009b). The NVC community U5 is not considered GWDTE (SEPA, 2017). However, the U6 community is classified as potentially moderately groundwater dependant depending on the hydrogeological setting (SEPA, 2017).

Neutral grassland

The Phase 1 Habitat category neutral grassland includes species-poor wet grasslands where soft rush and Yorkshire fog are abundant. The neutral grassland within the Satellite Launch Facility Study Area was dominated by soft rush. A single NVC community was described.

MG10a *Holcus lanatus – Juncus effusus* rush-pasture, typical sub-community

There were some small patches of MG10a rush pasture. These were damp swards where soft rush stood out amongst the other grassland and heath vegetation. Yorkshire fog was abundant below the rushes. The MG10a community was species poor, although occasional species such as white clover and marsh willow herb were present. Several small patches were mapped within the Satellite Launch Facility Study Area including within ditches. However, much of this community type was mapped as part of a mosaic as it appeared as small patches within other acid grasslands.

Marshy grassland

Marshy grassland, as described by the FWT, includes vegetation dominated by tussock forming grasses and rushes in damp soils. This includes the Phase 1 Habitat neutral grassland and NVC community MG10. The NVC communities MG10 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017).

Blanket bog

The bog within the Satellite Launch Facility Study Area was considered to be on peat which appeared deeper than 0.5m. In Phase 1 Habitat surveys bog-moss abundance is an indicator of whether bog should be classified as modified or unmodified, with '*sphagnum-rich vegetation'*, or '*abundant sphagnum'* indicating unmodified, and *'little to no sphagnum'* indicating modified bog (JNCC, 2010; Revised 2016).

All the bog within the Satellite Launch Facility Study Area had clearly been subject to modification through current and historic management practices including sheep grazing and drainage. There were areas of naturally occurring haggs, which occurred within the peatlands, and were likely to have been exacerbated by sheep. However, there were bog-mosses present, not always forming a carpet, but more frequent than *'little to no sphagnum'.* Therefore, the blanket bog has not been described as modified using Phase 1 Habitat terminology.

The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the bog habitat within the Satellite Launch Facility Study Area was clearly grazed and drained and there were patches of bare peat, using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Three NVC communities were described, including one bog pool community.

M2b *Sphagnum cuspidatum/fallax* bog pool, *Sphagnum fallax* sub-community

There were several small M2b bog pools in within the blanket bog and wet modified bog habitats. M2b bog pools were easily visible as bright green mats of flat-topped bog-moss (*Sphagnum fallax*). The carpet of flat-topped bog-moss was generally quite thin over peat. This community formed in the bases of peat haggs and in bog pool complexes usually with M3 pools. There were often few vascular plants within it including common sedge, common cottongrass and bent-grasses.

These bog pool communities were usually small or very small. Several M2b bog pools were mapped within the wet modified bog in the southwest of the Satellite Launch Facility Study Area. However, some were too small to mark on the map and examples are target noted.

M19 *Calluna vulgaris – Eriophorum vaginatum* blanket mire community

M19 blanket mire community is common in northern areas and tolerates drier peat than other NVC mire communities (Averis *et al.,* 2004).

It was dominated by heather with hare's-tail cottongrass (*Eriophorum vaginatum*) and common cottongrass both abundant. Crowberry (*Empetrum nigrum*) was a frequent dwarf shrub growing as a mat below the heather. There were a few occasional other graminoids but none formed any bulk of the vegetation, these included wavy hair-grass and heath rush. Tormentil was the commonest forb species.

Below the vascular plants, red bog-moss was abundant and constant, although its cover was patchy. Glittering wood-moss (*Hylocomium splendens*) was highly abundant and red-stemmed feather-moss was also frequent.

The M19 community was on a flat area in the north of the survey area which appeared to be waterlogged. It had some M2 and M3 bog pools present with damp patches of feathery bog-moss.

Although this community was distinctively M19, it did not show any of the described sub-communities characteristics and so it has been mapped as M19 and not given a sub-community.

M18 *Erica tetralix - Sphagnum papillosum* raised and blanket mire

There was a small area in the southwest of the Satellite Launch Facility Study Area that had a higher abundance of papillose bog-moss (*Sphagnum papillosum*) than the surrounding areas. Common cottongrass was dominant with hare's-tail cottongrass also more frequent than the surrounding area. Heather, cross-leaved heath (*Erica tetralix*) and crowberry were present as low, open dwarf shrub layer. Tormentil was abundant in the vegetation and there were several other forb species present including lousewort (*Pedicularis sylvatica*), heath spotted orchid, devil's-bit scabious (*Succisa pratensis*), bog asphodel (*Narthecium ossifragum*) and heath speedwell (*Veronica officials*). There were a series of M2a bog pools present.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally thicker than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). The Phase 1 Habitat blanket bog fits into this peat bog category and the NVC communities M2, M18 and M19 are within this FWT category. They are not considered to be potential GWDTE (SEPA, 2017).

Wet modified bog/wet heath

There was a large area in the west of the Satellite Launch Facility Study Area that was made up of wet heath vegetation usually dominated by heather with deergrass (*Trichophorum germanicum*), purple moor-grass and common cottongrass. There was less frequent crowberry, cross-leaved heath and bell heather (*Erica cinerea*).

In Phase 1 Habitat surveys, the classification of heath requires there to be greater than 25% cover of dwarf shrub and peat less than 0.5m deep or mineral soil (JNCC, 2010; Revised 2016; JNCC, 2012). Wet modified bog is defined as "*modified bog vegetation with little or no Sphagnum, often with bare peat and patches of* Trichophorum cespitosum *and/*or Molina Caerulea*. Ericoids may be abundant, sparse or absent. This vegetation is mainly found on drying and degraded blanket bogs … It may resemble wet heath, but is distinguished by having a peat depth greater than 0.5m"* (JNCC, 2010; Revised 2016; JNCC, 2012).

This demonstrates that where there is wet heath vegetation the key diagnostic feature classifying it, for Phase 1 Habitat purposes, is peat depth, with <0.5m being wet heath and >0.5m being wet modified bog (JNCC 2010, Revised 2016).

A peat depth survey was undertaken and demonstrated that a section of the wet heath vegetation was on peaty soils/peat between ca. 30cm and 65cm deep (Appendix 12.3). Which is at the transition point of these two Phase 1 Habitat types. Therefore, this vegetation type has been mapped as a transition of wet modified bog/wet heath. It was thought that some areas within the wet heath vegetation were likely to be on areas of deeper peat particularly around the M3 pools, and so would technically be wet modified bog. Nevertheless, some was clearly on shallower soils (meaning some areas were technically wet heath). Given the variation in peat depth the areas considered to be wet heath vegetation were defined as wet modified bog/wet heath.

It should be noted that this habitat survey does not constitute a formal peat depth survey. Visual clues from e.g. ditches, haggs, bedrock exposure and pushing a walking pole into the ground as well as professional judgement are used for habitat survey purposes. The peat depth survey data provides site specific evidence for peat depth in some parts of the Satellite Launch Facility Study Area (Appendix 12.3).

The PCA bases the condition of bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the wet modified bog/wet heath habitat within the Satellite Launch Facility Study Area was clearly grazed and drained using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the wet modified bog/wet heath would be considered of intermediate condition.

Two NVC communities were described as wet modified bog/wet heath, M15d and M15.

M15d *Trichophorum germanicum – Erica tetralix* wet heath, *Vaccinium myrtillus* sub-community

The M15d varied in its appearance across the Satellite Launch Facility Study Area with some locations having a taller, more apparent dwarf shrub layer. In other areas the graminoids, particularly cottongrass, were more apparent, with dwarf shrubs short or less conspicuous below. These differences are likely to be attributable to differing grazing regimes areas across the Satellite Launch Facility Study Area. The M15d community was drained and experienced grazing pressure from sheep.

There was a mixture of dwarf shrubs, including heather, crowberry and more occasionally cross-leaved heath and bell heather. Bilberry (*Vaccinium myrtillus*) was sparsely represented. The dwarf shrubs were usually short and over topped by grasses and sedges which is a common feature of this sub-community. Purple moor-grass, deergrass, heath rush, common cottongrass and mat grass were present too. Common cottongrass could be very abundant similar to the M15 community. Heath rush was often very conspicuous and, combined with the mat grass, some areas had some affinity with U6 grassland. There was a variety of other graminoids present including viviparous sheep's fescue (*Festuca vivipara*), wavy hair-grass and heath wood-rush.

Tormentil was generally the most common forb, but there were a variety of occasional other species including devil's-bit scabious, common butterwort (*Pinguicula vulgaris*), lousewort, round-leaved sundew (*Drosera rotundifolia*) and bog asphodel. The moss layer was not well developed but included patches of red bog-moss and more occasionally woolly fringe moss (*Racomitrium lanuginosum*).

There were occasional patches of hare's-tail cottongrass and there was a patch of M15d community in the north of the Satellite Launch Facility Study Area in which bog asphodel and devil's-bit scabious were highly abundant. Sheep's-bit was present, but only rarely and there was a record of goldenrod (*Solidago virgaurea*).

Pools were present within the M15d community. These were described as M2a and M3 bog pools. M3 were generally the most common.

M15 *Trichophorum germanicum – Erica tetralix* wet heath community

There were some small (too small to map), and one large area (forming a mosaic with other communities) in which the vegetation was strongly dominated by common cottongrass. Dwarf shrubs (heather and crowberry) were present, but below a common cottongrass carpet. This community was defined as M15, without an associated sub-community. It appeared to form a transitional habitat type, between the M3x and more distinct M15d.

Wet modified bog

In Phase 1 Habitat surveys, wet modified bog is defined as "*modified bog vegetation with little or no Sphagnum, often with bare peat and patches of* Trichophorum cespitosum *and/*or Molina Caerulea*. Ericoids may be abundant, sparse or absent. This vegetation is mainly found on drying and degraded blanket bogs … It may resemble wet heath, but is distinguished by having a peat depth greater than 0.5m.* Molina *dominated vegetation on deep peat is included in this category, rather than in marshy grassland"* (JNCC, 2010; Revised 2016; JNCC, 2012).

In the central part of the Satellite Launch Facility Study Area there were large areas of purple moor-grass dominated vegetation which was determined, as part of a subsequent site specific survey, to be on peat >0.5m (Appendix 12.3). As per Phase 1 Habitat classification this area has also been defined as wet modified bog, with marshy grassland vegetation over the peat.

The wet modified bog has been subjected to current and historic management practices including the grazing regimes and drainage as well as the extensive impact from historic military buildings and associated military uses.

It is considered possible that some areas, described as wet modified bog, are on shallower peat and/or sandy soils and so technically marshy grassland. However, on balance of the evidence, it has all been described as wet modified bog. It should be noted again that this habitat survey does not constitute a formal peat depth survey or soils survey. The peat depth survey data provides site specific evidence for deep peat (Appendix 12.3).

The PCA bases the condition of blanket bog on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). Given that the wet modified bog habitat within the Satellite Launch Facility Study Area was clearly grazed and drained using PCA terminology, the blanket bog was considered to be modified and some areas drained. Using the PCA Support Tool, the blanket bog would be considered of intermediate condition.

Two NVC communities were described as wet modified bog, M25b which was purple moor-grass dominated and M3x which was common cottongrass dominated.

M25b *Molinia caerulea – Potentilla erecta* mire, *Anthoxanthum odoratum* sub-community

The centre of Lamba Ness had a large area mapped as M25b. This area was heavily drained and sheep grazed. The drainage ditches were ca. 1m wide and 50-60cm deep, some were recently dug, with the spoil still evident beside them. They were not flowing with water at the time of the survey but were likely to be active drains in wetter times of the year. Draining and grazing are considered important in maintaining this particular sub-community of M25 (Rodwell, 1991).

The vegetation was 10-20cm tall and fairly variable but was dominated by purple moor-grass with mat grass abundant in places. Sweet vernal grass had lower abundance but was constant. There was also sheep's fescue and smooth meadow-grass frequently present. Common cottongrass could be very abundant in some places with common sedge and carnation sedge. Below these taller graminoids, tormentil was creeping through the vegetation with occasional creeping buttercup, devil's-bit scabious, ragged robin, white clover, common dog violet and selfheal occasionally present. Rarer forb species included dandelion, tufted vetch (*Vicia cracca*), mouse-ear, spring squill, sheep's-bit and heath spotted orchid. Common butterwort and bog asphodel were found, but only rarely, in the M25b community.

Bog-mosses were generally absent in the M25b community with only very occasionally red bog-moss. Dwarf shrubs were also generally absent, although small sprigs of heather were present in some stands.

Some small stands of M25b had an abundance of heath rush showing some affinity to U6 grassland, but in other respects were similar to that of the M25b community as a whole.

Within some stands of M25b there were open water pools, generally 2m×2m in size, but varying up to about 5m×5m in size. The pools were either bulbous rush dominated (NVC community A24) or common spike-rush dominated with lesser spearwort (NVC community S19a). Bent-grasses appeared to be common to all these pools. These communities were also found in drainage ditches and were common in some areas of M25b.

The M25b vegetation was set between coastal grassland and bog habitat. As the coastal grassland gave way to the M25b vegetation there was a period of transition between the habitat types.

M3x *Eriophorum angustifolium* community

There were areas dominated by common cottongrass that did not fit well within the NVC community descriptions as they appeared to be well developed. They clearly had affinity with the M3 community. However, the vegetation was usually a full cover, particularly of common cottongrass, rather than an establishing/stabilising community on exposed or redistributed peat as M3 usually is. Therefore, it has been denoted as M3x.

There were some small patches of M3x on Lamba Ness in old peaty channels, ditches and in some shallow hollows. These were dominated by common cottongrass, sometimes overwhelmingly so. Other species represented were tormentil, purple moor-grass, common yellow sedge and a little red bog-moss. However, there were also species related to the surrounding habitats, such as lesser spearwort, carnation sedge, ribwort plantain, marsh arrowgrass (*Triglochin palustre*), marsh pennywort (*Hydrocotyle vulgaris*), devils-bit scabious and marsh willowherb (*Epilobium palustre*).

There were some larger expanses of M3x within the M15d community in which common cottongrass was strongly dominant. Common cottongrass made up to 80-90% of the vegetation cover, and there was little dwarf shrub below it (<25% of the ground cover). However, there were generally a variety of other species, particularly tormentil but also devil's bit scabious, lousewort, heath spotted orchid and common dog violet. It is thought that these areas, mapped as M3x, represent a transitional point between M3 and M15. It is possible that some areas may have been on shallower peaty soils.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally deeper than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). Peat bogs are generally considered rainwater fed, and not considered to be potential GWDTE (SEPA, 2017). However, the NVC community M25 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017). M3 is not considered to be a potential GWDTE in SEPA guidance.

Bare peat

Bare peat was mapped where there were extensive areas of bare peat within the Satellite Launch Facility Study Area with common cottongrass was the main colonising species. This was seen as part of the hagging within the blanket bog and as bare peat areas in wet modified bog/wet heath. These may have been pools in wetter months.

The PCA bases the condition of peatlands on indicators such as bog-moss cover, extent of bare peat and evidence of grazing and burning (Peatland Action, 2016). In PCA terminology the bare peat was considered to be both modified and actively eroding. Using the PCA Support Tool, the blanket bog would be considered of bad condition.

One NVC community was mapped within the bare peat classification.

M3 *Eriophorum angustifolium* bog pool community

Areas that had a high proportion of bare peat with common cottongrass were mapped as the NVC community M3.

M3 is a species poor community, generally made up of common cottongrass on redistributed peat or areas where the peat bog has been lost. Within the Satellite Launch Facility Study Area, the majority of the M3 community was found in hagg fields, or bare peat areas within wet modified bog/wet heath.

In the hagg fields the M3 bare peat could be filled with water or as bare peat pans with little vegetation. In these areas common cottongrass with perhaps a little feathery bog-moss (*Sphagnum cuspidatum*) and/or flat-topped bog-moss were present.

Peat bog (peatland setting)

In the FWT peat bog is defined as wet peat, which is generally deeper than 0.5m, with heather, cottongrasses and some small sedge species (SNIFFER, 2009b). The Phase 1 Habitat bare peat could fit into this peat bog category (although some areas were not considered to be on peat >0.5m) and the NVC community M3 is within this FWT category. M3 is not considered to be potential GWDTE (SEPA, 2017).

Fen

Fens are defined as minerotrophic mires usually over deep peat. The fen community was dominated by common sedge. A single NVC community was described.

Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community

Dargie (1998a, 1998d) describes a provisional fen community that was not included in the original NVC publications. It is described as a rich fen, dominated by common sedge, developing in areas which are very wet, and poorly drained, but not inundated for long periods.

Within the Satellite Launch Facility Study Area there were several locations where the species composition best fit this provision NVC community descriptions. These areas were generally in damp hollows and seepage lines. Common sedge was dominant with purple moor-grass abundant. Sweet vernal grass and Yorkshire fog were also frequently present. Tormentil was the only forb with any prominence, although there were small amounts of bog asphodel, marsh willowherb and common dog violet.

Fen

In the FWT fen is defined as tall herb vegetation, including flowering plants, reeds, sedges and rushes (SNIFFER, 2009b). The NVC community Mxd was found in seepage lines and hollows and may fit within this FWT category. Mxd is not included in SEPA guidance (SEPA, 2017).

Dry dwarf shrub heath

Dry dwarf shrub heath was recorded within the Satellite Launch Facility Study Area. It was dominated by heather, with crowberry and bell heather both prominent. The dry dwarf shrub heath was found on steep slopes and on dry, raised patches within the blanket bog habitat in the north of the Satellite Launch Facility Study Area and within the wet modified bog/wet heath to the west of the Satellite Launch Facility Study Area. It was formed on peat which was apparently less than 0.5m deep, although it is possible some of the dry heath that was mapped was actually on dry (and degraded) deeper peat, with no visible indication of the peat depth.

There was a single dry heath NVC community described within the Satellite Launch Facility Study Area.

H10b *Calluna vulgaris* – *Erica cinerea* heath, *Racomitrium lanuginosum* sub-community

The H10b heath community was dominated by heather although the heather was grazed short giving an open structure. Bell heather and crowberry were both present, with crowberry abundant and a preferential for this sub-community along with the woolly fringe moss and lichens (*Cladonia spp.*). Mat grass and heath rush were common, as was purple moor-grass. Tormentil was a common forb along with devil's-bit scabious in some stands. There was occasionally heath wood-rush and common sedge present.

Dry heath communities are not considered to be wetland habitats in the FWT and are not potential GWDTE.

Acid flush

There was a small flush running downhill in the west of the Satellite Launch Facility Study Area. The flush was bog-moss dominated, with a variety of mosses, including flat-topped bog-moss. Common sedge and bulbous rush were the most common species, although they were sparse. It was mapped as a mosaic with the heath rush dominated acid grassland (U6) and as it became more diffuse on the lower slopes it was mapped as a mosaic with wet modified bog/wet heath (M15d) and acid grassland.

M6b *Carex echinata* – *Sphagnum fallax* mire, *Carex nigra* – *Nardus stricta* sub-community

The M6b sub-community was dominated by bog-mosses, particularly flat-topped bog-moss. Common haircap was occasional. The community was species poor, and sparsely vegetated over with common sedge and bulbous rush most common. Mat grass and heath rush were occasional, more at the transition with the U6 grassland than in the M6 community itself.

Seepage/Flush (slope settings)

In the FWT seepage/flushes are defined as variable vegetation associated with diffuse springs on hill slopes. This is similar to the Phase 1 Habitat acid flush and the NVC community M6. This category is defined as a potentially highly GWDTE (SEPA, 2017). According to the BGS geological maps the M6 was located in close proximity to the intersection between two different bedrock types, with the Saxa Vord Pelite Formation to the west and Skaw Intrusion to the east. This indicates a fault line (or some geological change), which can cause groundwater to discharge. It is, therefore, considered possible or even likely that the M6 flush was associated with groundwater.

Open vegetation

There were small patches of nettles, which fit the NVC community OV25. These were not mapped separately but formed very small stands within the acid grasslands.

OV25 *Urtica dioica – Cirsium arvense* community

There were occasionally, usually small, patches of nettles and/or creeping thistle (*Cirsium arvense*) across the Satellite Launch Facility Study Area, usually associated with the buildings and surrounding enriched grasslands.

This dominated community is not considered a wetland and is not a potential GWDTE.

Standing water

There were several small standing water pools within the Satellite Launch Facility Study Area. Most were dry, or partially dry at the time of survey. On Lamba Ness the marginal vegetation was often (but not exclusively) brackish in nature, while inland pools were more regularly dystrophic. Where there was marginal, emergent or inundation vegetation they were described separately.

Water margin and inundation vegetation

This habitat type comprises of emergent or frequently inundated vegetation. There were a number of small vegetated, or partly vegetated pools, and pool margins within the Satellite Launch Facility Study Area, particularly on Lamba Ness, with a variety of vegetation types within them. They were generally very small, being just a few meters in size. Some were mapped, and some target noted. A total of four water margin and inundation NVC communities were described:

- The pools dominated by common spiked-rush (*Eleocharis palustris*) were classed as NVC community S19a.
- Species poor marginal vegetation dominated by shoreweed was classed as NVC community A22a.
- Species poor marginal vegetation dominated by bulbous rush was classed as NVC community A24.
- A single area dominated by creeping bent and creeping buttercup was classed as NVC community OV28.

S19a *Eleocharis palustris swamp, Eleocharis palustris* sub-community

The S19a community was found in wet hollows on Lamba Ness. These areas were dominated by common spiked-rush standing in damp to wet ground at the time of the survey. Lesser spearwort was common in some stands but it was generally very species poor with limited records of common sedge and jointed rush. In one stand marsh pennywort was apparent and there was also occasional velvet bent, common chickweed and bulbous rush. This particular patch had some affinities with the S19c descriptions.

A22a *Littorella uniflora - Lobelia dortmanna* community, *Littorella uniflora* sub-community

There were two small areas where shoreweed dominated. One area was where peaty-sandy soil had been cut away in the past leaving a pool with shoreweed around the edges. The other area was over the foundations of an old building. Shoreweed formed a dense, species poor mat, where it was dominant with few other species recorded at the time of survey.

The pool had several large rocks within it and the water was smelly with thick algae growth.

A24 *Juncus bulbosus* community

There were some dry (at the time of survey) pools, with bare, cracked peaty soil which was poached by sheep. In these dried pools there was approximately 50% bare peaty soil and 50% bulbous rush, with some velvet bent also present. These areas were clearly water filled at certain times of the year.

OV28 *Agrostis stolonifera – Ranunculus repens* community

Creeping bent and creeping buttercup were found where a small stream met a small, sheltered beach. The stolons and runners were growing across a wet sandy surface substrate with a small 30cm wide stream running through the middle. There was also common chickweed, cuckooflower (*Cardamine pratensis*) and marsh willowherb occasionally present.

Swamp

Despite the association with pools, the water margins and inundation communities A22, A24, and OV28 are not considered to be wetlands in the FWT and are not listed as potentially GWDTE. S19 is considered as part of the swamp category in the FWT but is not listed as a potential GWDTE.

Watercourses and drains

There were a number of small watercourses across the Satellite Launch Facility Study Area (defined using the OS 1:25,000 maps), which were subject to artificial management and so were often straight and well defined. Drains were also mapped across the Satellite Launch Facility Study Area. These were generally associated with the wet modified bog and wet modified bog/wet heath. Some of the drains were target noted. They were usually about 1m wide and 50-60cm deep (but some were up to ca. 1m deep). A total of ca. 2.3km were mapped as watercourses with an additional ca. 2.2km mapped as ditches.

Bare ground

Some small areas were mapped as bare ground. These were either areas of bare sand or of exposed peaty-mineral soils.

Buildings and roads

Lamba Ness was previously a military base during the wars with associated infrastructure evident across the peninsula. Many of the military buildings were derelict and used as shelter by the livestock resulting in localised fertilisation. There were also some areas that were ruined, with only foundations remaining. Roads and tracks were mapped across the Satellite Launch Facility Study Area. These included the road that links Norwick and Skaw and the track that leads to the head of Lamba Ness.

Results – Saxa Vord and Northdale Road Study Area

The Phase 1 Habitat survey map for the Saxa Vord Study Area and the Northdale Road Study Area is shown in Appendix 7.2 Drawing 8 and a list of habitat types are displayed in Table 4. The NVC survey map of the Saxa Vord and Northdale Road Study Area is shown in Appendix 7.2 Drawing 9 with the potential GWDTE shown in Appendix 7.2 Drawing 10[2]. These drawings are supported with a list of target notes (Annex 1, Appendix 7.2 Drawing 11). Photographs of the habitats and interesting features are provided in Annex 2.

Overview

The centre of the Saxa Vord Study Area was largely made up of buildings, roads and car parking spaces. Much of the grassland around the buildings and roads was frequently mown amenity grassland with perennial rye grass and daisy. The most common habitat surrounding the buildings and roads was improved grassland which was subject to varying intensities of sheep grazing. There were small patches of semi-improved neutral grassland along road verges and in discrete, less intensively managed locations.

The Northdale Road Study Area was largely made up of improved grassland. There were also habitats that were consistent with those described in the Satellite Launch Facility Study Area including dry dwarf shrub heath and acid grassland. There were some small patches of neutral grassland most of which were mapped as a mosaic with the acid grassland and improved grassland.

Study Area	Phase 1 Habitats	Area (ha)	% of Study Area
Saxa Vord	Improved grassland	8.9	51.1
	Buildings and roads	5.5	31.5
	Amenity grassland	1.8	10.4
	Neutral grassland	1.2	7.0
	Total	**17.4**	**100**
Northdale Road	Improved grassland	6.6	41.4
	Acid grassland	3.4	21.3
	Dry dwarf shrub heath	3.2	20.3
	Acid grassland: neutral grassland	1.7	10.4
	Buildings and roads	0.5	3.2
	Neutral grassland	0.4	2.3
	Dry heath: acid grassland	0.1	0.7
	Neutral grassland: scrub	0.1	0.4
	Total	***16.0***	***100***

Table 4: The area of each of the Phase 1 Habitats found in the Saxa Vord Study Area and the Northdale Road Study Area.

[2] Drawings are provided within this document for ease of reference and higher resolution versions are provided separately as PDFs.

Habitat and Community Descriptions

Buildings and roads

The building and roads category includes the buildings and their gardens, roads, tracks, carparks and play courts. In the Saxa Vord Study Area the buildings included Saxa Vord Resort with restaurants, accommodation, a youth hostel and distillery. In the Northdale Road Study Area there were small sections of the existing road and some buildings. There is no associated NVC community.

Amenity grassland

Amenity grassland incudes intensively managed grassland which is regularly mown. It is typical of lawns and playing fields. Amenity grassland was common at Saxa Vord Resort. It contained a usual assemblage of species including perennial rye grass with daisy, white clover and creeping buttercup. There were occasional records of common sorrel (*Rumex acetosa*), red clover (*Trifolium pratense*), hogweed (*Heracleum sphondylium*), selfheal, bird's-foot trefoil and rarely heath spotted orchid.

The associated NVC community for this habitat is **MG7e *Lolium perenne – Plantago lanceolata* community** which is characteristic of verges and lawns which are regularly mown.

Amenity grassland is not considered to be a wetland and MG7 is not considered to be a GWDTE in SEPA's guidance.

Improved grassland

There was much improved grassland in the Saxa Vord Study Area and the Northdale Road Study Area which experienced a range of grazing intensity from sheep. Perennial rye grass was dominant in much of the improved grassland. In species poor fields the improved grassland was restricted to perennial rye grass, white clover with some Yorkshire fog, common sorrel and occasional bent grasses. In other fields a greater variety of grasses could be more prominent including Yorkshire fog, bent grasses and fescues. Sheep's sorrel, white clover and creeping buttercup were common forbs. In the fields surrounding the Northdale Road Study Area autumn hawkbit was prominent.

The associated NVC community for this habitat is **MG7 *Lolium perenne* leys**. Sub-communities ***MG7a Lolium perenne - Trifolium repens*** leys and **MG7b *Lolium perenne – Poa trivialis*** were both represented in the Saxa Vord and Northdale Road Study Areas. The MG7b could be fairly forb rich with red clover, white clover, autumn hawkbit, tormentil and lesser stitchwort all frequent in some stands, indicating that these fields receive light, or minimal, improvement.

There were occasional patches of creeping thistle in the improved grassland.

Improved grassland is not considered to be a wetland and MG7 is not considered to be a GWDTE in SEPA's guidance.

Neutral grassland

The Phase 1 Habitat category neutral grassland includes grasslands dominated by false oat-grass (*Arrhenatherum elatius*) and species-poor wet grasslands where soft rush and Yorkshire fog are abundant. The neutral grassland within the Saxa Vord Study Area and Northdale Road Study Area included three NVC communities **MG1a *Arrhenatherum elatius* grassland, *Festuca rubra* sub-community, MG9 *Holcus lanatus* – *Deschampsia cespitosa* grassland** and **MG10a *Holcus lanatus* – *Juncus effusus* rush-pasture, typical sub-community.**

MG1a was recorded along some road verges and in discrete patches within Saxa Vord Resort. False oat-grass was generally overwhelmingly dominant.

A small, rough grassland in the Northdale Road Study Area was dominated by creeping soft-grass (*Holcus mollis*) with red fescue and sweet vernal grass. Pignut was the most common forb, with common sorrel and creeping buttercup. This was a very poor fit to the MG9 community.

There were occasional small patches of MG10a in the damp, hollows of grassland field where soft rush stood out amongst the other grassland and heath vegetation.

There was a patch of semi-improved neutral grassland in the northwest of the Saxa Vord Study Area which was covered in a thick thatch of senesced plant material. Between the thatch red fescue was abundant with bent grasses. Tormentil was the most common forb. It was difficult to place this into an NVC community due to the thick thatch. It was considered best to include it in the MG1a community, but lacked the false oat-grass, which is an early stage of this community type.

Marshy grassland, as described by the FWT, includes vegetation dominated by tussock forming grasses and rushes in damp soils. This includes the Phase 1 Habitat neutral grassland and NVC community MG10. The NVC communities MG10 is considered potentially moderately groundwater dependant depending on the hydrological setting (SEPA, 2017).

Unimproved acid grassland

The mat grass dominated acid grassland in the Northdale Road Study Area was consistent with that of the Satellite Launch Facility Study Area and descriptions are not repeated here. The associated NVC community was **U5b *Nardus stricta* – *Galium saxatile* grassland, *Agrostis canina* – *Polytrichum commune* sub-community**. This acid grassland is also defined as a montane grassland in the FWT. U5 is not considered a potential GWDTE.

Where the existing footpath goes between farmland fields, there was a mosaic of dry dwarf shrub heath and acid grassland. This was similar to the **U4b *Festuca ovina* – *Agrostis capillaris* – *Galium saxatile* grassland, *Holcus lanatus* – *Trifolium repens* sub-community** descriptions form the Satellite Launch Facility Study Area descriptions, although was not grazed. Common bent, red fescue, sweet vernal grass and Yorkshire fog were frequent to dominant. There were a variety of forbs including creeping buttercup, autumn hawkbit, white clover and tormentil (NVC community U4b).

Along the current road verge, at Houlanbrindy in the north of the Northdale Road Study Area there was an abundance of wild flowers in the U4b grassland, including thyme, bird’s-foot trefoil, selfheal, autumn hawkwbit and sheep’s-bit. These were usually 1-3m along the road verge, too small to map and were generally present with exposed bedrock showing though. This likely best fit the **U4b** grassland NVC community, although with some base enrichment from the exposed bedrock.

Dry dwarf shrub heath

The heather dominated dry dwarf shrub heath in the Northdale Road Study Area was consistent with that of the Satellite Launch Facility Study Area and descriptions. The associated NVC community was ***H10b Calluna vulgaris – Erica cinerea heath, Racomitrium lanuginosum sub-community***. The H10b community was of short heather with crowberry, bell heather and tormentil. Wavy hair-grass, sweet vernal grass, mat grass and common sedge were occasional to frequent. Several field gentian (*Gentianella campestris*) were recorded along the trackway at the transition of dry heath and semi-improved grassland

Dry heath communities are not considered to be wetland habitats in the FWT and are not potential GWDTE.

Scrub

There was a small patch of Japanese rose (*Rosa rugosa*) in the Northdale Road Study Area. It was ca. 2m tall and was found along the existing road edge and in old, ruined buildings.

Evaluation

Habitat evaluation

No parts of the three Study Areas formed part of a site designated for biological features. There are several designated sites on Unst with features that are nationally or internationally important. The closest nationally designated site is Norwick SSSI which is adjacent to the Satellite Launch Facility Study Area to the southwest. It is designated for its geological features (NatureScot, 2020). A section of ca. 85m of this geological SSSI is within the Study Area, at the cliffs in southwestern edge (Appendix 7.2 Drawing 12).

Norwick Meadows SSSI is also very close to the Northdale Road Study Area (ca. 60m south) and relatively near to the Satellite Launch Facility Study Area (ca. 600m south) (Appendix 7.2 Drawing 12). Norwick Meadows SSSI is designated for its valley fen wetlands and sand dunes (NatureScot, 2020). The Northdale Road Study Area is particularly close to the Norwick Meadows SSSI. Improved grassland is the main habitat type between the road and the SSSI, with a small area mapped as marshy grassland and acid grassland mosaic. These communities do not form part of the designated feature of the SSSI.

The other designated sites on Unst are designated for bird species and/or for calaminarian grassland and serpentine heath (e.g. Keen of Hamar SSSI and SAC and Crussa Field and the Heogs SSSI) (NatureScot, 2020).

There are also several Local Nature Conservation Sites on Unst. These are listed in Table 5.

Local Nature Conservation Sites on Unst	Primary Interest	Justification for Local Nature Conservation Site
Baltasound	Species	Glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*).
Burn of Mailand	Species	Rare plants. Lesser tussock sedge (*Carex diandra*) and small bur-reed (*Sparganium natans*) are found nowhere else in Shetland. Rich bryophyte flora.
Haroldswick mires	Species	Schedule 1 bird species. The pool at Haroldswick is attractive to migrant birds. The base-rich mire vegetation is unusual in Shetland.
Lochs of Bordastubble and Stourhoull	Species	These water bodies are on the Unst serpentine; they are nutrient rich and support a variety of aquatic species. Breeding Schedule 1 bird species.
Skeo Taing	Species	The herb-rich turf with base-rich shell sand provides habitat for a diverse range of plants. The nationally rare autumn gentian (*Gentianella amarelle septentrionalis*) is found on site. This is the only site in Shetland where harebell (*Campanula rotundifolia*) may still occur.
Wick of Skaw	Geology	Easily identifiable exposure of a granite intrusion contact zone.
Belmont Quarry	Geology	Rock exposures across a major shear zone/ophiolite thrust. Part of the Shetland Ophiolite Suite.
Clibberswick Cross Geo	Geology	Part of the Shetland Ophiolite suite.
Hill of Clibberswick	Species	Two nationally scarce plant species are present on-site, Norwegian sandwort (*Arenaria norvegica*) and northern rock cress (*Arabis petraea*)

Table 5: The Local Nature Conservation Sites on Unst with their features of primary interest and the justification as specified in the Shetland Island Development Plan Local Nature Conservation Site guidance (SIC, 2015).

Some of the habitats described within the Satellite Launch Facility Study Area are similar to, or approaching descriptions for, Annex 1 habitats and/or SBL habitats. These include:

- Coastal grasslands;
- Saltmarsh;
- Sand dunes;
- Wet modified bog;
- Blanket bog;
- Wet modified bog/wet heath
- Fen;
- Dry dwarf shrub heath;
- Acid flush; and
- Water margin vegetation.

Dry dwarf shrub heath was also recorded in the Northdale Road Study Area and may have been similar to, or approaching, Annex 1 habitats and/or SBL habitats descriptions.

Coastal grassland

The Annex 1 habitats vegetated sea cliffs of the Atlantic and Baltic coasts are described as "*vegetated sea cliffs are steep slopes fringing hard or soft coasts, created by past or present marine erosion, and supporting a wide diversity of vegetation types with variable maritime influence*" and "*The most exposed areas support maritime vegetation dominated by a range of salt-tolerant plants*". The description of Annex 1 habitat vegetated sea cliffs includes the NVC communities MC8 and MC10 (EC, 2013). The coastal grassland communities within the Satellite Launch Facility Study Area meet these descriptions. The coastal grasslands in the Satellite Launch Facility Study Area also meet the description of the UK BAP habitat maritime cliffs and slopes which is a SBL habitat.

No clear published account of the total area of coastal grassland in Shetland was found. There is an estimated 12,000ha (120km^2) of coastal grasslands in Scotland and 22,138ha (221.38km^2) in the UK (JNCC, 2020). There was a total of 19.6ha of coastal grassland recorded within the Satellite Launch Facility Study Area (0.16% of the Scottish total). Given that Shetland has much grazed grassland around its extensive coastline it is not considered likely to be a particularly rare habitat type in Shetland, although it is considered to be potentially species rich and ecological valuable habitat (PlantLife, 2014). The sheep grazed coastal grassland within the Satellite Launch Facility Study Area was relatively species rich and contained a good assemblage of species. The area is grazed throughout the summer period, which may limit species richness (PlantLife, 2014). No particular Shetland rarities were recorded in the coastal grassland and it has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with coastal grasslands as a citation feature (NatureScot, 2020; SIC, 2015). Following due consideration of the range of factors listed in the guidance (CIEEM, 2018) the coastal grasslands within the Satellite Launch Facility Study Area were considered to be of local importance.

Sand dune

The sand dune habitats within the Satellite Launch Facility Study Area are similar to the Annex 1 habitats descriptions for embryonic shifting dunes, which includes the NVC community SD4, and fixed dune vegetation, which includes NVC community SD8. The Annex 1 habitat description for embryonic shifting dunes states that "*Embryonic shifting dunes vegetation exists in a highly dynamic state and is dependent on the continued operation of physical processes at the dune/beach interface. It is the first type of vegetation to colonise areas of incipient dune formation at the top of a beach*." It goes on to say "*Embryonic shifting dunes are inherently species-poor and have a limited range of floristic variation. The predominant plants are strandline species such as sea rocket* Cakile maritima *and the two salt-tolerant, sand-binding grasses: lyme-grass* Leymus arenarius *and sand couch* Elytrigia juncea" (JNCC, 2020). The SD4 sand dune community described in the Satellite Launch Facility Study Area is considered to meet these descriptions.

The Annex 1 habitat description for fixed dune vegetation states that "*Fixed dune vegetation occurs mainly on the largest dune systems, being those that have the width to allow it to develop. It typically occurs inland of the zone dominated by marram* Ammophila arenaria *on* *coastal dunes, and represents the vegetation that replaces marram as the dune stabilises and the organic content of the sand increases*. This description does not closely match what was seen in the Satellite Launch Facility Study Area and what habitat was present was a very small example of sand dune and dune grassland.

The sand dunes in the Satellite Launch Facility Study Area meet the description of the UK BAP Habitat coastal sand dunes which is a SBL habitat. There was a total of 0.3ha of sand dunes mapped within the Satellite Launch Facility Study Area. There is estimated to be 1,040ha (10.4km^2) of sand dune vegetation in Shetland including 3.4ha of embryonic dunes and 239.3ha of fixed dunes (Dargie, 1998a). There is an estimated 50,000ha (500km^2) of sand dunes in Scotland (70,000ha (700km^2) in the UK) (JNCC, 2020). The Scottish total for embryonic dunes is 90ha (295ha for the UK), whereas the fixed dune vegetation is much more common with an estimated 14,800ha (148km^2) in Scotland (22,400ha (224km^2) in the UK) (JNCC, 2020).

Dargie (1998b) states that "*The nature conservation interest of the site [Inner Skaw] is low due to small site area and limited range of vegetation*". This 2018 survey supports this statement, as the vegetation is sparse, generally species poor with limited examples of dune vegetation and is small in size. The embryonic dunes make up ca. 9% of the regional total and 0.3% of the Scottish total. Much of it was bare sand, and it has been considered to be of low conservation interest due to its limited size and range of vegetation. However, it is nearby to a SSSI designated for the sand dune features, namely Norwick Meadows SSSI. Therefore, on balance, the value of the sand dune vegetation within the Satellite Launch Facility Study Area is elevated and considered to be of regional importance.

Saltmarsh

Saltmarsh is included in the Annex 1 habitat Atlantic salt meadows which includes the NVC community SM16. The description of Annex 1 habitat Atlantic salt meadows states that Atlantic salt meadows "*develop when halophytic vegetation colonises soft intertidal sediments of mud and sand in areas protected from strong wave action. This vegetation forms the middle and upper reaches of saltmarshes, where tidal inundation still occurs but with decreasing frequency and duration*". The description of Annex 1 habitat Atlantic salt meadows does not include perched saltmarshes and the description does not fit closely to the type of saltmarsh community found within the Satellite Launch Facility Study Area and so does not meet this criteria. Saltmarsh habitats are on the SBL. Using the UK BAP habitat definitions saltmarsh is also restricted to intertidal areas with the upper limit being one metre above the level of highest astronomical tides (Maddock, 2011). These do not take into account perched saltmarsh as found in the Satellite Launch Facility Study Area.

Perched saltmarsh is a relatively rare (and likely under-recorded) habitat type in Scotland and across the UK (Haynes, 2016). The saltmarsh survey of Scotland describes perched saltmarshes as "*often very small or present as short saltmarsh turf on cliff tops, which makes them difficult to map. These marshes are likely recorded more frequently as part of cliff vegetation surveys and may be interpreted as being closely associated with maritime cliff vegetation, rather than saltmarsh*" (Haynes, 2016). A total of 0.4ha of perched saltmarsh was recorded within the Satellite Launch Facility Study Area with additional areas too small to map. No area metric for perched saltmarsh is given in the saltmarsh survey of Scotland.

Nevertheless, the saltmarsh recorded in this 2018 survey appears to be the most northerly recorded in the UK. However, it was generally species poor with saltmarsh rush sometimes the overwhelmingly dominant species present. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site. Baltasound, which is ca. 6km away is a Local Conservation Site with the saltmarsh species glasswort (*Salicornia europea*) and annual sea-blite (*Suaeda maritima*) a justification citation feature. (SIC, 2015). These species were not found in the Satellite Launch Facility Study Area and the type of saltmarsh, specifically perched saltmarsh, is not a feature of designated sites.

The perched saltmarsh in the Satellite Launch Facility Study Area could be considered to be of regional importance because it is a relatively rare habitat in the UK and it appears to be the most northerly saltmarsh in the UK. However, the area of perched saltmarsh in the Satellite Launch Facility Study Area is tiny and species poor. It is not an Annex 1 or SBL habitat and it is likely under-recorded in the UK. Taking all these aspects into consideration the small area of perched saltmarsh is considered to be of local importance.

This survey supports Haynes (2016) who states that "*It is likely that there is more perched saltmarsh present across Scotland than is currently recorded. The vegetation is strongly associated with the 'MC' classification and further research into the vegetation of maritime cliffs is required*".

Blanket bog

The blanket bog (M18, M19), wet modified bog (M25, M3) and wet modified bog/wet heath (M15) transition are all considered within this section.

All blanket bog, regardless of condition, is listed by European legislation, under Annex 1 of the Habitats Directive (Directive on the Conservation of Natural Habitats and Wild Fauna and Flora EC/92/43). This includes wet heath, M15, but not M25 (European Commission, 2013). Active, peat forming blanket bog has a priority status. 'Active' blanket bog is defined as "*supporting a significant area of vegetation that is normally peat-forming. Typical species include the important peat-forming species, such as bog-mosses* Sphagnum *spp. and cottongrasses* Eriophorum *spp., or purple moor-grass* Molinia caerulea *in certain circumstances, together with heather* Calluna vulgaris *and other ericaceous species*. *Thus sites, particularly those at higher altitude, characterised by extensive erosion features, may still be classed as 'active' if they otherwise support extensive areas of typical bog vegetation, and especially if the erosion gullies show signs of recolonisation*" (JNCC, 2019).

Blanket bog, including degraded blanket bog with wet heath vegetation (M15) and purple-moorgrass (M25) is listed as a SBL habitat.

The blanket bog habitat in the Satellite Launch Facility Study Area had an abundance of common cottongrass with heather and other ericaceous species such as cross-leaved heath and crowberry. Bog-mosses were present, but not generally as a continuous carpet. Erosion and grazing pressures were evident.

A PCA of the blanket bog in the Satellite Launch Facility Study Area was undertaken during the Phase 1 Habitat and NVC survey. All of the blanket bog in the Satellite Launch Facility

Study Area was considered to be modified through grazing. Some of the blanket bog (degraded areas of M3) was also considered likely to be actively eroding with erosion features and bare peat present. This has been displayed in Appendix 7.2 Drawing 6. Using the ‘PCA support tool’ the blanket bog in the Satellite Launch Facility Study Area was considered to be of intermediate condition, with areas of bad quality where the erosion was most pronounced (areas of M3).

The blanket bog considered to be in best ecological condition, specifically for the Satellite Launch Facility Study Area, was considered to be the M18 and M19 communities.

Using the evidence provided here, and the ‘PCA Support Tool’, the blanket bog within the Satellite Launch Facility Study Area could be judged as inactive and likely to be an atmospheric carbon source, rather than a carbon sink. However, this is a rough, subjective tool, and doesn’t take into account subtleties and variation within the bog. Certainly, the eroding blanket bog is thought to be a carbon source rather than a sink and so unlikely to be active. But, given the northern location of the Satellite Launch Facility Study Area, and the reasonable quality of at least some of the blanket bog there is a degree of uncertainty as to its activity status or not. Therefore, it is considered that the M18 blanket bog may be active/partially active and the M19 blanket bog in the Satellite Launch Facility Study Area is likely to be mostly inactive but may have some areas that are still partially active. Therefore, the blanket bog in the Satellite Launch Facility Study Area is considered to be approaching Annex 1 priority habitat definitions.

The PCA considered that the areas of wet modified bog and wet modified bog/wet heath transition in the Satellite Launch Facility Study Area to be modified through grazing with some areas drained (Appendix 7.2 Drawing 6). Using the ‘PCA Support Tool’ the wet modified bog and wet modified bog/wet heath transition in the Satellite Launch Facility Study Area were considered to be of intermediate condition and unlikely to be normally active.

There is an estimated 2,224,104ha (22,241km^2) of blanket bog in the UK (JNCC, 2020) and 1,759,000ha (17,590km^2) in Scotland (JNCC, 2020). Blanket bog (in a variety of conditions) is a widespread and common habitat across Shetland. There is an estimated 53,430ha (534.3km^2) of peatland (which in Shetland is considered synonymous with blanket bog as there is little e.g. fen habitat) with additional areas also mapped as a mosaic with peatland (19km^2) (The Macaulay Institute, 1993).

The Satellite Launch Facility Study Area had 2.6ha of blanket bog habitat (including matrix with bare peat). Although some of the blanket bog met UK BAP and Annex 1 habitat definitions and may have been approaching Annex 1 priority habitat definition, there is considerably less than 1% of the national and regional total (0.0001% and 0.005% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

The Satellite Launch Facility Study Area had a further 37.5ha of wet modified bog/wet heath transitional habitat (including matrixes). This is considerably less than 1% of the national and regional total of blanket bog (0.002% and 0.07% respectively). Therefore, the quantity, size and condition of wet modified bog/wet heath habitat is not considered to be of national or regional importance.

The Satellite Launch Facility Study Area had a further 24.2ha of wet modified bog habitat. Again, this is considerably less than 1% of the national and regional total of blanket bog (0.001% and 0.05% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

The Satellite Launch Facility Study Area had a combined total of 64.3ha of bog habitats (including blanket bog, wet modified bog and wet modified bog/wet heath). The total of these habitat types is considerably less than 1% of the national and regional total (0.004% and 0.1% respectively). Therefore, the quantity, size and condition present is not considered to be of national or regional importance.

Furthermore, the Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site. The area is not near site designated for conservation importance with blanket bog as a citation feature or justification feature (NatureScot, 2020; SIC, 2015), although Haroldwick mires, which are ca. 3.8km away, has base-rich mire vegetation which is unusual in Shetland (SIC, 2015). Therefore, the blanket bog within the Satellite Launch Facility Study Area does not form an important wildlife corridor or link between important designated blanket bog patches.

The carbon and peatland maps show a small section of the northwest of the Satellite Launch Facility Study Area as having peatland with peatland vegetation (Category 1), which is consistent with the location of much of the blanket bog habitat mapped in the Satellite Launch Facility Study Area and with the areas of pools in the wet modified bog/wet heath transition. Class 1 is described as "*Nationally important carbon-rich soils, deep peat and priority peatland habitat. Areas likely to be of high conservation value*" (Scotland's Soils, 2017). The areas depicted as wet modified bog is mapped as Class 5 peat soils with no peatland vegetation, and the area mapped as wet modified bog/wet heath transition is mostly mapped as Class 4 - predominantly mineral soil with some peat soil with the vegetation described as heath with some peatlands.

Following due consideration of these the size, quality and condition of the blanket bog, and considering the widespread nature of blanket bog (in various conditions) in Shetland and on Unst, the blanket bog within the Satellite Launch Facility Study Area was considered to be of local importance. The wet modified bog/wet heath transitional habitat was considered to be of local importance. The wet modified bog was considered to be, at best, of local importance.

Wet modified bog/wet heath

The wet modified bog/wet heath has been assessed as both wet heath and wet modified bog within the blanket bog evaluation.

Wet dwarf shrub heath is included in the upland heath SBL habitat. Using the UK BAP definitions for this habitat in favourable condition is defined as "*dominated by a mixture of cross-leaved heath, deergrass, heather and purple moor-grass over an understory of bog-moss*" (Maddock, 2011). Annex 1 Northern Atlantic wet heath includes M15 wet heath (JNCC, 2020). There is an estimated 467,714ha (4,677km^2) of wet dwarf shrub heath in the UK and 370,000ha (3,700km^2) in Scotland (JNCC, 2020). There is an estimated 16,500ha (165km^2) of heather moorland in Shetland, with additional areas of mosaics making a further 37,400ha (374km^2; The Macaulay Institute, 1993). There was 37.5ha of wet modified bog/wet dwarf shrub heath within the Satellite Launch Facility Study Area, (including mosaics). The combined total is much less than 1% (0.2%) of the Shetland total.

The wet modified bog/wet heath has been subjected to current and historic management practices of grazing and draining. It was fairly species poor, with common cottongrass often a dominant component. The Satellite Launch Facility Study Area is not designated as a SSSI or Local Nature Conservation Site for wet dwarf shrub heath. There is no nearby designated site with wet dwarf shrub heath as a citation or justification feature (NatureScot, 2020; SIC, 2015). Therefore, the wet modified bog/wet heath within the Satellite Launch Facility Study Area does not form an important wildlife corridor or link between important designated blanket bog patches. The wet modified bog/wet heath in the Satellite Launch Facility Study Area was not considered to be of particularly high ecological value but may have some restoration potential. Following due consideration of these factors, and also those listed in the best practice guidance (CIEEM, 2018), the wet dwarf shrub heath was evaluated as being of local importance.

Dry heath

Dry dwarf shrub heath is included in the upland heath SBL habitat. Using the UK BAP definitions for this habitat in favourable condition it is defined as being “*dominated by dwarf shrubs such as heather, bilberry, crowberry, and bell heather*” (Maddock, 2011). Annex 1 European dry heath includes dwarf shrub dominated vegetation with heather, bilberry and bell heather (JNCC, 2020). Some of the dry dwarf shrub heath may have been approaching these definitions, but it was found in small patches, within a mosaic of blanket bog. There is an estimated 893,540ha (8,935km^2) of dry dwarf shrub heath in the UK and 479,000ha (4,790km^2) in Scotland (JNCC, 2020). There is an estimated 16,500ha (165km^2) of heather moorland in Shetland, with additional areas of mosaics making a further 37,400ha (374km^2; The Macaulay Institute, 1993). There was 0.7ha of dry dwarf shrub heath within the Satellite Launch Facility Study Area with an additional 6.5ha mapped as a mosaic. There was a further 3.3ha (including mosaics) mapped within the Northdale Road Study Area. The combined total is considerably less than 1% (0.06%) of the total in Shetland. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with dry dwarf shrub heath as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Therefore, the dry heath within the Satellite Launch Facility Study Area does not form an important wildlife corridor or link between important designated dry heath patches. Consequently, the dry dwarf shrub heath was not considered to be of sufficient quantity or quality to be nationally or regionally important and was evaluated as being of local importance.

Acid flush

Acid flush is listed as a SBL habitat categorised. Using the UK BAP habitat definitions upland flush is defined as ‘peat or mineral-based terrestrial wetlands in upland situations, which receive water and nutrients from surface and/or groundwater sources as well as rainfall. It is a varied habitat category but is typically dominated by sedges and their allies, rushes, grasses and occasionally wetland herbs and/or a carpet of bryophytes’ (Maddock, 2011). The flush habitat (NVC community M6) within the Satellite Launch Facility Study Area is equivalent to this definition. Upland flush UK BAP habitat is widespread but local throughout the uplands of Scotland (Maddock, 2011). The extent has not been recorded as it has not been comprehensively surveyed in many areas and tends to occur in small, sometimes numerous stands (Maddock, 2011). There was a single flush habitat in the Satellite Launch Facility Study Area making up just 0.3ha of acid flush recorded (including mosaics). This habitat type is widespread across Scotland. The quantity of this habitat within the Satellite Launch Facility Study Area was small and unconnected to other areas of this habitat type. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with acid flush as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), the upland flush habitat was considered to be of local importance (but see GWDTE evaluation).

Water margin vegetation

The Annex 1 habitat oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) is described as "*This type of waterbody is restricted to sandy plains that are acidic and low in nutrients, and are therefore very scarce. The water is typically very clear and moderately acid*". The description goes on to say "*The habitat type is characterised by the presence of Littorelletalia-type vegetation. Such vegetation is characterised by the presence of water lobelia* Lobelia dortmanna, *shoreweed* Littorella uniflora, *or quillwort* Isoetes lacustris. *Only one species needs to be present to conform with the definition of this Annex I type and typically the vegetation consists of zones in which the individual species form submerged, monospecific lawns*" (JNCC, 2020). This habitat type is considered rare (JNCC, 2020). The SBL habitat oligotrophic and dystrophic lakes also includes the shoreweed community A22 (Maddock, 2011). The shoreweed community A22 within the Study Area is similar to these descriptions, particularly the pool which was on a peaty-sandy soil and species poor with shoreweed forming a carpet around the edge of a pool, although the pool was smelly with thick algae growth at the time of the survey. The pool in the Satellite Launch Facility Study Area was very small, with a small patch of the community on one edge. The Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with acid flush as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), the marginal vegetation habitat, specifically the NVC community A22, was considered to be of potentially regional importance due to its relative rarity.

Upland grassland

The upland grassland communities *Juncus squarrosus – Festuca ovina* grassland and *Nardus stricta – Galium saxatile* grassland are on the SBL. There are no descriptions for these in the UK BAP habitat descriptions (as they were not UK BAP habitats), but they correspond to the NVC communities U5 and U6. These are widespread community types in Scotland and Shetland (Scottish Government, 2013). They are also considered to require a '*watching brief only*' within the SBL. The Satellite Launch Facility Study Area has not been identified as a location of particular conservation importance in Shetland, such as a SSSI or Local Nature Conservation Site nor is it near one with upland grasslands as a citation feature or justification feature (NatureScot, 2020; SIC, 2015). Following due consideration of not only these factors, but also others listed in the guidance (CIEEM, 2018), these upland grassland communities are considered to be of local importance.

Fen

A variety of fens are Annex 1 habitats and SBL habitats. The small amount of common sedge dominated community did not correspond well to these descriptions. Consequently the ‘fen’ habitat was considered to be of site importance.

Species evaluation

Only one of the plant species recorded during field surveys in 2018 was identified as being on the SBL. This was field gentian which was recorded along the trackway in the Northdale Road Study Area.

Oysterplant, which was recorded in the fore-dune community, is an LBAP species and considered Near Threatened and Nationally Scarce and scarce in Shetland.

No other vascular species recorded during field surveys of the three Study Areas in 2018 were identified as an LBAP species or in the lists of rare and scarce species for Shetland (Scott *et al.,* 2002). Considerations of previous records within and near the three Study Areas are provided separately within the Shetland Space Centre Natural Heritage Desk Study.

There was no evidence of any notifiable non-native invasive species (e.g. Japanese knotweed) within the three Study Areas during walkover surveys. It should be noted that species distribution varies temporarily and spatially. The non-native invasive species Japanese knotweed is known to occur on Unst, including near Saxa Vord Resort (NBN Atlas, 2020) and so a watching brief should be kept for this species.

Groundwater dependant terrestrial ecosystems evaluation

GWDTE are defined as '*A terrestrial ecosystem of importance [at Member State level] that are directly dependent on the water level in or flow of water from a groundwater body (that is, in or from the saturated zone)*' (UKTAG, 2003). UKTAG defines pressures on GWDTE as '*being important when there is, or likely to be, significant damage on a GWDTE*' (UKTAG, 2005). Significant damage is defined as:

- '*the degree of damage occurring to a GWDTE (caused by groundwater related factors); and*
- the significance or conservation value of the ecosystem.' (UKTAG, 2005).

It has been suggested that non-statutory sites should be judged as significantly damaged if any groundwater-dependent ecosystem which is a UK BAP priority habitat is judged as damaged or declining for reasons of inadequate groundwater quality or quantity (UKTAG 2005).

SEPA's Guidance Note (2017) recommends that the listed NVC communities should be treated as GWDTE unless information can be provided to demonstrate they are not dependent on groundwater. SEPA (2017) does recognise that some of these communities are common across Scotland and that these communities may be considered GWDTEs only in certain hydrogeological settings or may have limited dependency on groundwater in certain hydrogeological settings.

NVC communities recorded in the three Study Areas that are considered in the guidance (SEPA, 2017) to be potentially groundwater dependent include:

- M6 *Carex echinata – Sphagnum fallax* mire;
- M15 *Trichophorum cespitosum – Erica tetralix* wet dwarf shrub heath;
- M25 *Molinia caerulea – Potentilla erecta* mire;
- MG9 *Holcus lanatus – Deschampsia cespitosa* grassland;
- MG10 *Holcus lanatus – Juncus effusus* rush-pasture;
- MG11 *Festuca rubra – Agrostis stolonifera – Potentilla anserine* grassland community; and
- U6 *Juncus squarrosus – Festuca ovina* grassland.

One NVC community that is not in the SEPA guidance, which was considered to be a potentially GWDTE (due to the association with similar/related communities that are listed as a potentially GWDTE), is:

- Mxd *Carex nigra* provisional fen, *Molinia caerulea* sub-community; and

Of these, only M6 is considered to be potentially highly groundwater dependent, depending on the hydrological setting (SEPA, 2017). All the other communities are considered potentially moderately groundwater dependent, depending on the hydrological setting (SEPA, 2017). All mosaics of habitat were allocated their GWDTE category according to the NVC community with the highest potentially GWDTE.

The bedrock for the majority of the Satellite Launch Facility Study Area was the Skaw Intrusion which was describe as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures; rare springs*" (BGS, 2020b). To the far west of the Satellite Launch Facility Study Area the bedrock is *Hevda Phyllite Formation which was also* described a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b). Therefore, the majority of the potentially GWDTE are considered most likely to be present due to waterlogged conditions sustained by high rainfall in the region, rather than groundwater for their maintenance.

The M6 community was located at the transition between the two bedrock types in the Satellite Launch Facility Study Area. This can be a source location for GWDTE, where groundwater is released at a spring or seepage line (McMullen, 2020). It is, therefore, considered that the M6 community may be an actual GWDTE.

In the Saxa Vord and Northdale Road Study Areas there were some habitats that were mapped as mosaics with MG10 and MG9, which are considered potentially moderately groundwater dependent depending upon the hydrological setting. The bedrock was Gruting Greenschist Formation for the Saxa Vord Study Area and Norwick Phyllite Formation for Northdale Road Study Area. Both of which were described as a "*Low productivity aquifer*" with "*small amounts of groundwater in near surface weathered zone and secondary fractures*" (BGS, 2020b). These areas of MG9 and MG10 may also be sustained by high rainfall in the region, rather than groundwater for their maintenance. However, the sensitive, nationally important, SSSI wetland habitats downhill of these potential GWDTEs should be considered in relation to the Saxa Vord and Northdale Road development, particularly as there may be some interconnection through ground or surface water.

A qualified hydrologist should be consulted to determine if the potential GWDTEs identified within this report are actual GWDTEs.

Table 6 displays the relationship between NVC communities, Phase 1 Habitats, FWT categories and the groundwater dependency as stated by SEPA (2017).

Phase 1 Habitat	NVC Community	FWT Category	Guidance potential GWDTE	Setting	Comment on setting	Comment on potential GWDTE
Wet modified bog/wet heath	M15	Peat bog	Potentially moderately GWDTE	Lower slopes and westward side of the Satellite Launch Facility Study Area	Set on peat with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Wet modified bog	M25	Peat bog	Potentially moderately GWDTE	Centre of Lamba Ness peninsula	Set on peat with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Fen	Mxd	Fen	Not included	Centre of Lamba Ness peninsula	In seepage lines and hollow	Potentially GWDTE, but likely that most influence is from the heavy rainfall and surface water movement – assigned moderate
Blanket bog	M19,	Peat bog	Not a GWDTE	Peat bog	Ombrotrophic	Not a GWDTE
Bare peat	M3	Peat bog	Not a GWDTE	Peat bog	Ombrotrophic	Not a GWDTE
Dry dwarf shrub heath	H10	Not a wetland	Not a GWDTE			Not a GWDTE
Acid flush	M6	Flush	Potentially highly GWDTE	Hill slope	Located at/near a change in the bedrock type	Potentially highly GWDTE
Acid grassland	U5 U6	Montane grassland Montane grassland	Not a GWDTE Potentially Moderately GWDTE	 With wet heath and other acid grasslands	 Set on peaty-sandy soils with the bedrock classed as a low productive aquifer	Not a GWDTE Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Coastal grassland	MC8, MC10 MG11	Not a wetland Wet grassland	Not a GWDTE	 Lamba Ness peninsula		

Phase 1 Habitat	NVC Community	FWT Category	Guidance potential GWDTE	Setting	Comment on setting	Comment on potential GWDTE
			Potentially Moderately GWDTE		Set on thin peaty-sandy soils with the bedrock classed as a low productive aquifer	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region
Saltmarsh	SM16	Saltmarsh	Not a GWDTE			Not a GWDTE
Sand dunes	SD4, SD8		Not a GWDTE			Not a GWDTE
Neutral grassland	MG9 and MG10	Marshy grassland	Potentially Moderately GWDTE	In ditches and as part of a mosaic within acid grasslands MG9 and mosaic of MG10 with acid and improved grassland in the Northdale Road Study Area	The MG10 community found in ditches is likely to be influenced mostly from the surface water rather than groundwater. Where it was associated with other grassland it was on thin peaty-sandy soils with the bedrock classed as a low productive aquifer Some was uphill of SSSI designated wetland habitats	Potentially low GWDTE, but likely that most influence is from the heavy rainfall in the region Potential for connection with SSSI habitats
Water margins and inundation	S19 A22 A24 OV28	Swamp Not a wetland (standing water) Not a wetland (standing water) Not a wetland	None classed as GWDTE			None classed as GWDTE

Table 6: The relationship between Phase 1 Habitats, NVC communities, FWT categories and the GWDTE category defined by SEPA (2017).

Discussion

Satellite Launch Facility Study Area

There were a wide variety of habitat and plant communities described within the relatively small Satellite Launch Facility Study Area, with a total of 18 Phase 1 Habitats mapped and described using standard methods, plus a further three Phase 1 Habitat mapped as mosaics. A total of 28 NVC communities were found and described using standard survey methods. Many of these habitats were typical of Shetland, including wet modified bog, wet modified bog/wet heath, blanket bog, coastal grassland and acid grassland. There were also areas of sand dunes and pools with marginal vegetation.

Of the habitats present in the Satellite Launch Facility Study Area wet modified bog/wet heath was the most common (26% of the Satellite Launch Facility Study Area) closely followed by wet modified bog (24% of the Satellite Launch Facility Study Area) and coastal grassland (17% of the Satellite Launch Facility Study Area).

The dry dwarf shrub heath, blanket bog, wet modified bog, wet modified bog/wet heath, dune grassland, coastal grassland, acid flush and water margin vegetation habitats were evaluated as being approaching or equivalent to the descriptions of the SBL habitat and/or Annex 1 habitat descriptions, with blanket bog approaching Annex 1 priority habitat descriptions. The sand dune habitat and a water margin habitat were assessed as being of regional importance. The other habitats were evaluated as being of local importance due to a combination of factors including condition, size and the widespread nature of the habitat in Shetland.

Several habitats in the Satellite Launch Facility Study Area, including wet modified bog and neutral grassland, were assessed as being potentially moderately groundwater dependent. The acid flush habitat (NVC community M6) was assessed as potentially highly GWDTE.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered and special attention paid to the sand dune and the water margin (specifically the A22 community) habitats in the Satellite Launch Facility Study Area, as well as the potentially GWDTE, particularly the potentially highly GWDTE acid flush (NVC community M6).

Saxa Vord Study Area

The Saxa Vord Study Area held a small number of habitats and communities, all of which are common in and around built-up areas and agricultural land. These included frequently mown amenity grassland, improved grassland, buildings and roads and small patches of neutral grassland along road verges and in discrete, less intensively managed locations.

None of these habitats were considered to have particular ecological importance or sensitivities. The non-native invasive species Japanese knotweed is known to be present on Unst, including a patch near the Saxa Vord Study Area and so a watching brief should be kept for this species.

The MG10 grassland in the Saxa Vord Study Area, was assessed as being potentially moderately groundwater dependent. It was assessed as potentially being hydrologically connected to the nationally important, designated wetland habitats in Norwick Meadows SSSI. Care should be taken to ensure there are no direct or indirect impacts on these potentially sensitive habitats and the adjacent designated site.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered.

Northdale Road Study Area

The Northdale Road Study Area had a small number of habitats present, which were considered to be typical of Shetland. These included dry dwarf shrub heath, acid grassland, improved grassland and small patches of neutral grassland most of which were mapped as a mosaic with the acid grassland and improved grassland.

The dry dwarf shrub heath was evaluated as being approaching the descriptions of the SBL habitat and Annex 1 habitat descriptions. It was assessed as being of local importance.

The MG9 and MG10 grassland in the Northdale Road Study Area, was assessed as being potentially moderately groundwater dependent. It was assessed as potentially being hydrologically connected to the nationally important, SSSI designated wetland habitats in Norwick Meadows. Care should be taken to ensure there are no direct or indirect impacts on these potentially sensitive habitats and the adjacent designated site.

When assessing the potential impact of the proposed development, the presence and importance of the habitats present should be considered and special attention paid to the nearby SSSI designated site and the potential for hydrological connectivity of wetland habitats within the Northdale Road Study Area.

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Annex 1: Target Notes

TG no.	Grid reference	Note
1	HP 66382 15287	An example of coastal grassland (NVC community MC8d) dominated by red fescue with white clover and thrift.
2	HP 66457 15310	An example of a hollow within the MC8d grassland where sheep lie and fertilise. There was sheep's fescue, common chickweed and rough meadow-grass.
3	HP 66480 15304	An exposed profile of soil demonstrating a thin richer (peaty soil) layer at the top, followed by a sandy-humus layer quickly changing into a thin gravel layer then a layer of finer sand below. The sheep clearly use this for shelter as there is evidence of dunging and wool left on the edge.
4	HP 66549 15241	An example of coastal grassland (NVC community MC10b), which had an abundance of sedges.
5	HP 66570 15314	There was a small flow of water running to the cliff edge and an old, dry ditch channel which was dominated by saltmarsh rush with lesser spearwort (NVC community SM16b).
6	HP 66572 15335	Part of an old ditch which was dominated by common cottongrass (NVC community M3x).
7	HP 66568 15362	There was a ca. 8m×5m area dominated by common spike-rush (NVC community S19a).
8	HP 66557 15361	A patch of sedge dominated coastal grassland (NVC community MC10d) where common sedge and carnation sedge were of very high abundance.
9	HP 66573 15407	Drainage ditches were present across the entre of Lamba Ness, within the wet modified bog (NVC community M25b). This target note is an example of a ditch which was approximately 50cm deep and 75cm wide. It was dry during the survey. There was occasionally Pyrenean scurvygrass (*Cochlearia pyrenaica*) in the ditches.
10	HP 66525 15384	An example of wet modified bog (NVC community M25b), a common habitat in the centre of Lamba Ness. It was dominated purple moor-grass, with common cottongrass and mat grass.
11	HP 66526 15384	Heath spotted orchids were found within the wet modified bog at this location.
12	HP 66843 15475	There were bright green patches of grassland (NVC community MG11) surrounding the old military buildings. These areas were nutrient rich and heavily grazed from sheep congregating around them for shelter.
13	HP 66856 15414	There were a series of dry pools, bare peat cracked and poached by sheep. There was approximately 50% bare peat and 50% bulbous rush, with some velvet bent also present. These areas were likely to be water filled at certain times of the year. There was a ditch than went to the road, which had the same dried pool community (NVC community A24).
14	HP 66863 15341	There was a wide, open water pool at this location. Clearly an area where peaty soils had been removed. The pool had several large rocks, peat stained water and was smelly with algae growth. At the edges there were mats of shoreweed (NVC community A22a).
15	HP 66863 15341	An example of improved coastal grassland, (NVC community MG11) around a military building. There was about 3m wide strip of this nutrient enriched grassland. It was dominated by perennial rye grass with buttercup and common chickweed.
16	HP 66876 15345	An example of coastal grassland (NVC community MC8d) with thrift and plantains abundant.
17	HP 66706 15298	An example of a sheep laying area with the coastal grassland. There was an increased abundance of common chickweed.
18	HP 66675 15311	An old ditch channel which was dominated by saltmarsh rush (NVC community SM16b).
19	HP 66653 15368	An example of vegetation dominated by common spiked-rush (NVC community S19a). There was bare peat around it at the time of the survey, with bulbous rush and velvet bent. The common spiked-rush was in deeper channels.
20	HP 66595 15370	Shoreweed and velvet bent dominated area (NVC community A22a) on damp peaty soil on an old building foundation. At the time of survey it was damp, but likely to be a pool during wetter times of year.

TG no.	Grid reference	Note
21	HP 66581 15366	There was an old embankment/wall going northwards across Lamba Ness. The vegetation was coastal grassland (NVC community MC10d), but the graminoids were taller than the surrounding grassland.
22	HP 66593 15298	There was an abundance of silverweed within the coastal grassland (NVC community MC8d) at this location.
23	HP 66642 15297	There was a 50cm×50cm ditch at this location 50% filled with vegetation. There was a combination of velvet bent, sea plantain, ribwort plantain, buckhorn plantain, red fescue, thrift, saltmarsh rush and arrowgrass.
24	HP 66719 15383	There were a series of dried out pools within the wet modified bog (NVC community M25b). They were either bulbous rush dominated (NVC community A24) or common spike-rush dominated, with velvet bent common (NVC community S19a). The area was mapped as a matrix of M25b:A24:S19a at a ratio of approximately 80:10:10.
25	HP 66749 15306	There was a 2-3m wide patch, within a seepage line, with abundant sea arrowgrass. Red fescue, common cottongrass and purple moor-grass were all abundant with frequent sea plantain, and occasional chickweed, and Yorkshire fog. The surrounding part of this seepage line was made up of NVC community M3x, S19a, SM16 and A24.
26	HP 66857 15481	An example of a small shallow pool (dry at the time of survey) within the wet modified bog (NVC community M25) habitat. The dominant species in this pool was velvet bent.
27	HP 66892 15511	An example of the community S19a, dominated by common spike-rush. Marsh pennywort was common was abundant in this stand.
28	HP 66894 15518	There was a little red bog-moss in the wet modified bog (NVC community M25b) at this location. It was with some heather on the side of a ditch.
29	HP 66896 15601	An embankment around a military building had maritime grassland (NVC community MC10a) with the more nutrient rich maritime grassland (NVC community MG11a) surrounding the base.
30	HP 66896 15601	There was a patch of maritime grassland (NVC community MC8d) which appeared to be over a concrete of gravel surface. Thrift and daisy were more common in this patch.
31	HP 66838 15556	There was a dry ditch at this location with a spoil pile beside it. The ditch was straight, 1m wide and 60cm deep. There was a little velvet bent along the base. The spoil line was 1.5m wide and was drier than the surrounding vegetation.
32	HP 66836 15576	There was a wet ditch at this location with a little bog pondweed within it. There was also lesser spearwort, velvet bent, common cottongrass and bulbous rush occasionally present.
33	HP 66782 15567	There were two, man-made, circular pools at this location. They were made up of common spiked rush (NVC community S19a) with a bog pondweed surrounding it. Other species located here were marsh willowherb, marsh cinquefoil, cuckooflower and bog asphodel.
34	HP 66783 15574	There was a small patch of soft rush dominated area within the wet modified bog (NVC community M25b). It had an increase of some wetland species such as marsh marigold, marsh pennywort and marsh willowherb, and was moving towards an M23 community, although the abundance of purple moor-grass and common cottongrass resulted in it being part of the M25b community.
35	HP 67178 15407	There was a mostly dried out, un-vegetated, pool at this location. The base was of gravel and sands with some cobbles.
36	HP 67166 15350	There was a small (1m×3m) patch of saltmarsh rush dominated habitat (NVC community SM16b) in this location on a sandy substrate.
37	HP 67216 15375	An example of less species rich coastal grassland (NVC community MC10a).
38	HP 67249 15419	A small (5m×5m) dry, un-vegetated area with gravel and sand substrate. This may well be a pool at wetter times of year.
39	HP 67360 15396	A small wet pool, 4m×4m in size, with boulders and a sand/gravel substrate. There were some very small patches of saltmarsh rush (NVC community SM16b) around it.
40	HP 67487 15500	The coastal grassland (NVC community MC10b) at this location was more species poor than previously noted with fewer forbs. Sedges were still common in the grassland (giving the MC10b sub-community).

TG no.	Grid reference	Note
41	HP 67457 15500	The improved coastal grassland (NVC community MG11) at this location lacked any perennial rye grass.
42	HP 67433 15500	The improved coastal grassland (NVC community MG11) at this location included marsh thistle, and silverweed was highly abundant.
43	HP 67407 15600	An example of the coastal grassland (NVC community MC10a) where sea plantain was the dominant species.
44	HP 67167 15497	There was a steep cliff edge at this location that had been used as a rubbish dump. There was a large pile of glass, metal, plastic debris.
52	HP 67096 15536	There was a small, shallow, draining channel at this location, dominated by salt-marsh rush (NVC community SM16b) with an orangey brown muddy substrate below.
53	HP 67070 15528	There was a small bowl, shaped hollow dug out of the rock at this location. It was mostly grassed over with coastal grassland (NVC communities MC10a and MC10b). There was also a small dug out dry pool next to this location which had a sand and mud base.
54	HP 66600 15411	There were many dug out ditches within the wet modified bog (NVC community M25b) along this location with the fresh spoil along the side, which appeared sandy.
55	HP 66719 15547	There was an area dominated by well-established common cottongrass (NVC community M3x) either side of a ditch. The ditch had pondweed and marsh pennywort within it.
56	HP 66727 15563	A patch of fen (NVC community Mxd) where common sedge was dominant.
57	HP 66764 15760	There was a patch of mat grass dominated unimproved acid grassland (NVC community U5a) at this location.
58	HP 66755 15749	A patch of fen (NVC community Mxd) where common sedge was dominant.
59	HP 66664 15758	There was a patch of heath rush dominated U6 vegetation at this location.
60	HP 66615 15716	There was a historic wall or dyke at this location, located under the vegetation, but slightly raised within the wet modified bog (NVC community M25b). The vegetation on top was drier as the ground was free draining. It was about 2m across.
61	HP 66505 15701	The semi-improved acid grassland (NVC community U4b) at this location was highly grazed and quite tussocky. There were signs of a historic enclosure or terracing.
62	HP 66425 15416	There was a dried, scorched area of grassland (unidentified NVC community) at this location which had grown over an old tarmac road.
63	HP 66311 15732	There was fore-dune vegetation (NVC community SD4) at this location going to a small, sheltered beach.
64	HP 66309 15763	There was a narrow section of dune grassland (NVC community SD8d) at this location.
65	HP 66307 15754	There was a small, sheltered beach at this location.
66	HP 66305 15773	There was a flush of vegetation (NVC community OV28) at this location with running water meeting the sea.
67	HP 66281 15712	The semi-improved acid grassland (NVC community U4b) at this location was heavily sheep grazed. Daisy and perennial rye grass was abundant showing a strong affinity with more improved grassland types (MG7).
68	HP 66289 15549	There was a small seepage line of NVC community Mxd at this location, draining downhill towards the beach. It was dominated by common sedge with marsh pennywort, lesser spearwort and marsh willowherb.
69	HP 66090 15491	There was a 0.5-2m wide stripe of semi-improved acid grassland (NVC community U4b). There were a variety of forbs along the road verge and there were small patches where species such as silverweed were prominent.
70	HP 66063 15465	There was a dug out area at this location, with an old foundation. There were rock faces. The vegetation was fairly nutrient enriched with a combination of improved coastal grassland (NVC community MG11) and semi-improved acid grassland (NVC community U4b) and some small patches of nettle (NVC community OV25).
71	HP 66047 15400	There were large areas of wet modified bog/wet heath (NVC community M15d) in this location.
72	HP 65968 15301	There were a series of retaining walls with common sedge the most abundant species in the wet modified bog (NVC community M25b) along the top. These appeared to be holding back water with bog pools present behind it.

TG no.	Grid reference	Note
73	HP 65877 15277	There were several bog pools at this location. They were relatively wet, and filled with bog-moss, common sedge and common cottongrass (NVC community M2b).
74	HP 65877 15272	There were some large areas around this location which were mapped as the NVC community M3x. They had 100% cover of vegetation, with common cottongrass making up 80-90% of the vegetation. Dwarf shrubs were generally absent.
75	HP 65851 15328	There were small patches of NVC community M15d within the NVC community M3x vegetation. These were usually small (5m×5m) It was slightly raised and distinguished by the dwarf shrubs and heath rush.
76	HP 65826 15372	There were areas of wet modified bog that were between NVC communities M3x and M15d where common cottongrass were highly abundant, but dwarf shrubs were present below. Tormentil was highly abundant in these stands.
77	HP 65840 15385	There was a ca. 2m deep, 8m wide hole at this location. Heath rush dominated acid grassland (NVC community U6) was along the sides and there was semi-improved acid grassland (NVC community U4b) at the base.
78	HP 65835 15464	There was often a mixture of communities within the wet modified bog/wet heath with acid grassland habitats present in low proportions. (NVC communities M15, M3x, M15b and U6. At this location it was in a ratio of 60:20:10:10).
79	HP 65776 15549	This perennial rye grass and daisy semi-improved acid grassland (NVC community U4b with affinities to MG7) had patches of marsh, spear and creeping thistle. There were occasional tussocks of soft rush and heath rush.
80	HP 65919 15580	There was a mixture of highly grazed semi-improved acid grassland (NVC community U4b) with perennial rye grass and daisy, patches of mat grass dominated unimproved acid grassland (NVC community U5b) and patches of neutral grassland (NVC community MG10a) where soft rush was the dominant species.
81	HP 65824 15703	There were lots of small patches of soft rush dominated neutral grassland (NVC community MG10a) within the semi-improved acid grassland (NVC community U4b). It was dominated by soft rush, with Yorkshire fog.
82	HP 65792 15665	There was a dense patch of marsh thistle at this location around the foundations of an old military building.
83	HP 65827 15789	An example of wet modified bog/wet heath (NVC community M15d).
84	HP 65906 15865	There was round-leaved sundew within the wet modified bog/wet heath (NVC community M15d) at this location.
85	HP 65917 15876	There was a circular hole in the ground here (borrow pit perhaps), approximately 8m in diameter and 2m deep. There was a mixture of semi improved acid grassland and neutral grassland (NVC communities U4b and MG10a) within it. It was used as shelter by sheep. Thyme was recorded here. A drystone wall was nearby.
86	HP 66172 15782	There was a cutting at this location through the wet modified bog/wet heath (NVC community M15d). It was a straight line, 2-3m wide and long. It was vegetated down the sides and there was no water in it at the time of the survey.
87	HP 66150 15731	The acid grassland (NVC community U6) at this location had patches in which heath rush was highly abundant.
88	HP65457 15176	There was semi-improved acid grassland (NVC community U4b) at this location with patches of heath rush dominated acid grassland (NVC community U6).
89	HP 65532 15169	At the fence to the sea cliffs there was a 2-5m wide stripe of ungrazed semi-improved acid grassland (NVC community U4b). It was tall with fescues and bent-grasses, sheep's sorrel, tormentil and creeping buttercup.
90	HP 65598 15221	There was a flushed area rich in common sedge and lesser spearwort.
91	HP 65600 15267	The blanket bog (M18) at this location was dominated by common cottongrass over a patchy layer of papillose and red bog-moss. Cross-leaved heath, heather and crowberry were all evident under the common cottongrass layer.
92	HP 65447 15317	The wet modified bog/wet heath (NVC community M15d) around this location was characterised by an undulating ground. On the drier tops heather, deergrass, common cottongrass and heath rush were common. In the hollows red bog-moss, common cottongrass, bog asphodel and tormentil were more common.

TG no.	Grid reference	Note
93	HP 65495 15517	There was a patch of semi-improved acid grassland (NVC community U4b) with perennial rye grass and daisy. Clearly frequented by sheep and consequently enriched. There were also patches of soft rush, marsh thistle and nettles.
94	HP 65479 15502	There was a large borrow pit at this location, ca. 5m deep. It was filled with semi-improved acid grassland (NVC community U4b) with small patches of soft rush and heath rush.
95	HP 65545 15487	There was a common sedge dominated flush (NVC community Mxd) at this location with an area of exposed peat with common cottongrass the main species present (NVC community M3).
96	HP 65631 15538	The wet modified bog/wet heath (NVC community M15d) at this location was highly grazed and trampled. Red bog-moss was hummocky at this location.
97	HP 65582 15546	There was a small area beside a ditch that was dominated by common sedge with tormentil (NVC community Mxd).
98	HP 65418 15898	There were extensive areas of hagging in the blanket bog (NVC community M19) with bog pools (NVC communities M2a and M3) and areas of bare peat.
99	HP 65393 15896	There was a complex within the blanket bog habitat with blanket bog (NVC community M19), bog pools (mostly NVC community M3) and dry dwarf shrub heath (NVC community H10b). The ratio was approximately 50:40:10. There were extensive areas of hagging in the blanket bog. An M2 pool was located here with common sedge and flat-topped bog-moss.
100	HP 65400 15901	The blanket bog (NVC community M19) at this location was relatively wet, with the water table just below the surface.
101	HP 65402 15903	The blanket bog complex included areas of dry dwarf shrub heath (NVC community H10b), these were on drier hummocks within the blanket bog.
102	HP 65504 15722	There was another complex of bog pools (including NVC communities M3 and M2a) and bare peat within the wet modified bog/wet heath (NVC community M15d) at this location. There was some chickweed, floating sweet-grass and bent-grasses with the blunt-leaved bog-moss and common sedge. Bulbous rush was also present.
103	HP 65522 15721	There were large bog pools at this location (30m×40m). They were mostly exposed bare peat at the time of survey, but likely to be water filled in wetter months.
104	HP 65476 15653	There was an area of blanket bog (NVC community M19) at this location, with hare’s-tail cottongrass was prominent.
105	HP 65296 15707	There was a patch of acid grassland (NVC community U6) along a steep bank near a military building at this location.
106	HP 65300 15687	There was a view of the Satellite Launch Facility Study Area at this location.
107	HP 65212 15751	Potential GWDTE. There was a bog-moss dominated flush (NVC community M6) running downhill at this location. Bog-mosses dominated with occasional common sedge and bulbous rush over the bog-moss layer. On slightly raised ground heath rush dominated acid grassland (NVC community U6).
108	HP 65342 15461	An example of heath rush dominated acid grassland (NVC community U6).
109	HP 65396 15464	There was a borrow pit cut into the rock besides the road. It as vegetated with a white clover rich form of semi-improved acid grassland (NVC community U4b).
110	HP 65413 15464	In the semi-improved acid grassland (NVC community U4b) at this location, within a borrow pit, the grassland was short (<5cm), with a variety of forbs including selfheal and daisy. Thyme was occasional on drier patches. Yorkshire fog was abundant here. Wavy hair-grass was more common on the slopes of the borrow pit.
111	HP 65175 15324	The dry dwarf shrub heath (NVC community H10b) here had abundant crowberry and woolly fringe moss.
112	HP 65251 15326	There was a patch of highly grazed heath rush dominated acid grassland (NVC community U6). Heath rush was dominant throughout, but in wetter areas, in hollows common cottongrass and bog asphodel were abundant, in drier areas mat grass and tormentil were more abundant.
113	HP 64359 13300	Amenity grassland was very common within the Saxa Vord Study Area. It was dominated by perennial rye grass, with daisy and white clover. Regularly mown.
114	HP 64362 13304	There was a very small patch of neutral grassland at this location within the Saxa Vord Study Area which had not been cut but left for wildflowers. Oxeye

TG no.	Grid reference	Note
		daisy was particularly common with large scabious, hogweed, ribwort plantain, clover, bird's-foot trefoil, soft meadow grass and false oat-grass.
115	HP 64479 13433	The regularly mown amenity grassland at this location included fescues and occasional selfheal and hogweed.
116	HP 64502 13473	False oat-grass dominated the road verges.
117	HP 64519 13423	The improved grassland at this location included perennial rye grass, with creeping buttercup and white clover.
118	HP 64483 13502	The neutral grassland at this location was covered in a thick thatch of senesced plant material. Red fescue was the dominate grass between the thatch.
119	HP 64122 13405	The improved grassland at this location included perennial rye grass, creeping buttercup, white clover, common sorrel, hogweed, Yorkshire fog and occasionally yellow rattle.
120	HP 64115 13388	There was a dense stand of creeping thistle at this location.
121	HP 64436 13557	Creeping thistle was common at this location.
122	HP 64433 13495	Nettles were common at this location.
123	HP 64401 13136	Japanese knotweed was located here.
124	HP 64317 14267	This was an area of dry dwarf shrub heath dominated by short heather with crowberry, bell heather and tormentil. Wavy hair-grass, sweet vernal grass and mat grass were occasional.
125	HP 64316 14329	The road verge along here was forb rich with sheep's-bit, thyme, bird's-foot trefoil. The grasses included red fescue, common bent and sweet vernal grass.
126	HP 64327 14337	The improved grassland field was dominated by sweet vernal grass and Yorkshire fog. There was occasional cock's-foot, bent grasses, perennial rye grass and Timothy. It was fairly forb rich, particularly noticeable was autumn hawkbit. There was also white clover, red clover, tormentil, lesser stitchwort and more rarely eyebright. The improved grassland field is likely to have had relatively little improvement in recent times.
127	HP 64349 14230	There was a ruderal area at this location with pineapple weed and broad-leaved dock.
128	HP 64424 14193	There was an overgrown dyke, or boundary wall, within the grassland at this location. There were occasional patches of soft rush in the grazed field.
129	HP 64396 14180	The improved grassland at this location included Yorkshire fog and sweet vernal grass. Daisy was very abundant. There was also heath wood-rush and autumn hawkbit. It was heavily grazed by sheep.
130	HP 64400 14184	The road verge was species rich, with autumn hawkbit, sheep's-bit, thyme, heather, bird's-foot trefoil, selfheal and eyebright.
131	HP 64328 14232	There was a ruderal area at this location, including a spoil heap with silverweed growing on it.
132	HP 64326 14218	Around the gate of this improved grassland field pineapple weed was dominant.
133	HP 64321 14211	Dry dwarf shrub heath made up the vegetation on one side of the trackway whilst semi-improved grassland U4b made up the other side of the trackway. The dry heath similar to other areas (NVC community H10b). The grassland appeared unmanaged, with common bent, red fescue, sweet vernal grass and a variety of forbs (NVC community U4b).
134	HP 64328 14201	The field on the east side of the track was heavily grazed with white cover and daisy prominent.
135	HP 64323 14148	The west side of the track the grassland was grazed but was dominated by mat grass with tormentil, Autumn hawkbit as prominent. There were several orchid spikes, but they had senesced. They were likely to be heath-spotted orchid or a marsh orchid.
136	HP 64324 14056	There were several field gentians at this location, at the transition of dry heath and semi-improved grassland.
137	HP 64298 14021	The dry heath at this location was on flatter ground than the surrounding dry heath. It was fairly grassy with wavy hair-grass and common bent.
138	HP 64269 14021	Bird's foot-trefoil was common on the track at this location. The surrounding dry heath included common sedge, woolly fringe moss and lichens.
139	HP 64197 13945	This MG7b field was recently grazed by sheep. It included sweet vernal grass, Yorkshire fog, perennial rye grass white clover and autumn hawkbit.
140	HP 64166 13918	This field was similar to other rich MG7b, with no recent improvements, and grazing low at during this season. Yorkshire fog and sweet vernal grass were dominant. White clover and mouse ear were frequent.

TG no.	Grid reference	Note
141	HP 64171 13901	This area of rough grassland was made up of soft meadow grass, sweet vernal grass, red fescue and pignut. Common sorrel was also frequent. There was much senesced material below, indicating that it was not grazed recently.
142	HP 64118 13912	The road verges along here were dominated by false oat-grass (NVC community MG1).
143	HP 64119 13913	The improved grassland fields along this area were recently cut. They appeared to have been dominated by perennial rye-grass with Timothy (MG7a).
144	HP 64114 13960	There was Japanese rose scrub along the roadside here, besides a tumbled down wall. There was also honey suckle, elder and false oat-grass.
145	HP 64111 13986	The Japanese rose scrub along the side of the road at this location. False oat-grass was dominant along the verge. There was a garden escapee at this location too.
146	HP 64105 13992	There was a strip of semi-improved neutral grassland (NVC community MG1) at this location rich in dock, common sorrel and creeping buttercup.
147	HP 64118 13872	The road verges were semi-improved neutral grassland (NVC community MG1) at this location.

Annex 2: Photographs

Photo 1: MC8d Red fescue – thrift grassland (TG1).

Photo 2: MC10b Red fescue – plantain spp. grassland (TG4).

Photo 3: Saltmarsh rush (SM16b) in an old, peaty, ditch/cutting (TG5).

Photo 4: M3x dominated by common cottongrass on Lamba Ness (TG6).

Photo 5: An example of a dry ditch on Lamba Ness at OS grid reference HP 66573 15407 (TG9).

Photo 6: Wet modified bog (M25b) on Lamba Ness (TG10).


Photo 7: Bright green improved coastal grassland (MG11) around old military buildings (TG12).


Photo 8: An example of a seasonally dry pool on Lamba Ness (TG13).


Photo 9: Shoreweed (A22a) growing as a mat on the edge of a man-made pool (TG14).


Photo 10: Common spiked-rush (S19a) within a channel on Lamba Ness (TG19).


Photo 11: Shoreweed dominated community (A22a) growing in in the foundations of an old building (TG20).


Photo 12: An example of MC10a maritime grassland (TG37). It was dominated by sea plantain with thrift and fescues.

Photo 13: An example of MG11 around military buildings. Silverweed is prominent at this location (TG42).

Photo 14: A rubbish dump over the edge of the cliff at Lamba Ness (TG44).

Photo 15: A recently dug ditch with the fresh sandy spoil on the side (TG54).

Photo 16: Well-established M3x common cottongrass dominated vegetation beside ditch. (TG 55).

Photo 17: Sand dune vegetation at a sheltered beach (TG63-65).

Photo 18: Perennial rye grass and daisy were abundant in the highly grazed U4b grassland at this location. (TG 67).

Photo 19: Common cottongrass was dominant, with few shrub shrubs present in the M3x community (TG 74).

Photo 20: Common cottongrass was dominant over heather in the wet modified bog/wet heath (NVC community M15) (TG 76).

Photo 21: Soft rush was dominant in the MG10a neutral grassland (TG 81).

Photo 22: Round-leaved sundew in wet dwarf shrub heath (NVC community M15d) (TG 84).

Photo 23: The blanekt bog at this location was rich in pappilose bog-moss (NVC community M18) (TG 91).

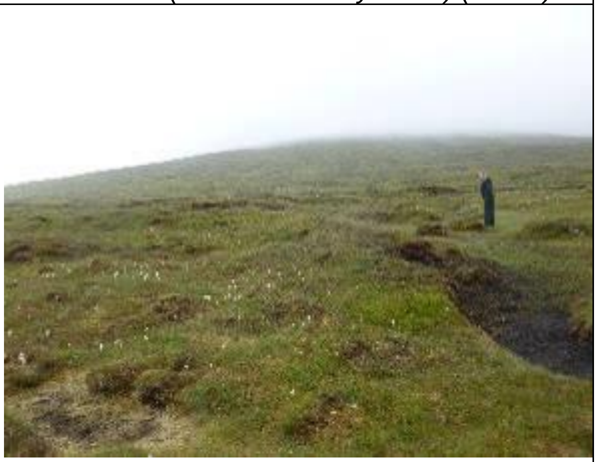


Photo 24: There were extensive areas of hagging in the blanket bog (NVC community M19) *(TG 98).*

Photo 25: The blanket bog complex included areas of dry dwarf shrub heath (NVC community H10b), these were on drier hummocks within the blanket bog (TG101).

Photo 26: There were large bog pools at this location (30m×40m). They were mostly exposed bare peat at the time of survey, but likely to be water filled in wetter months (TG103).

Photo 27: A view of an extensive area of wet modified bog/wet heath (TG106).

Photo 28: A Potential GWDTE. There was a bog-moss dominated flush (NVC community M6) running downhill. On slightly raised ground heath rush dominated acid grassland (NVC community U6) (TG107).

Photo 29: Amenity grassland at Saxa Vord Resort (TG112).

Photo 30: A patch of neutral grassland where oxeye daisy was abundant (TG113).

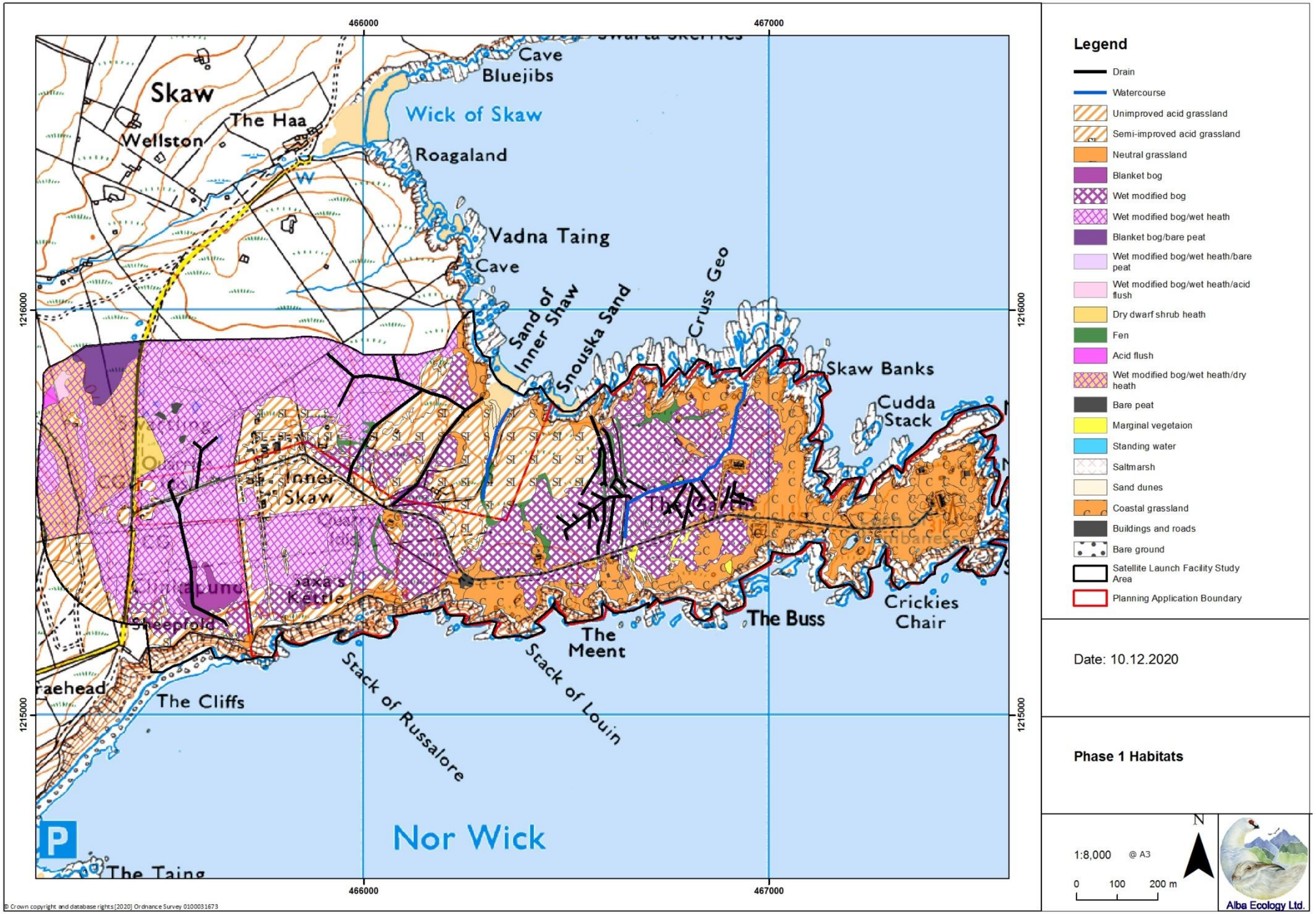
 Photo 31: Road verges were dominated by false oat-grass (TG116).	 Photo 32: There was a thick thatch of senesced plant material at this location (TG118).
 Photo 33: Improved grassland in the Saxa Vord Study Area (TG119).	 Photo 34: Japenses knotweed just outside Saxa Vord Study Area (TG123).
 Photo 35: Species rich imporved grassland in the Northdale Road Study Area (TG126).	 Photo 36: The road verge was species rich with thyme, sheep's-bit, autumn hawkbit and bird's-foot trefoil (TG130).

Photo 37: The track way was made up of dry dwarf shrub heath and acid grassland (TG133).

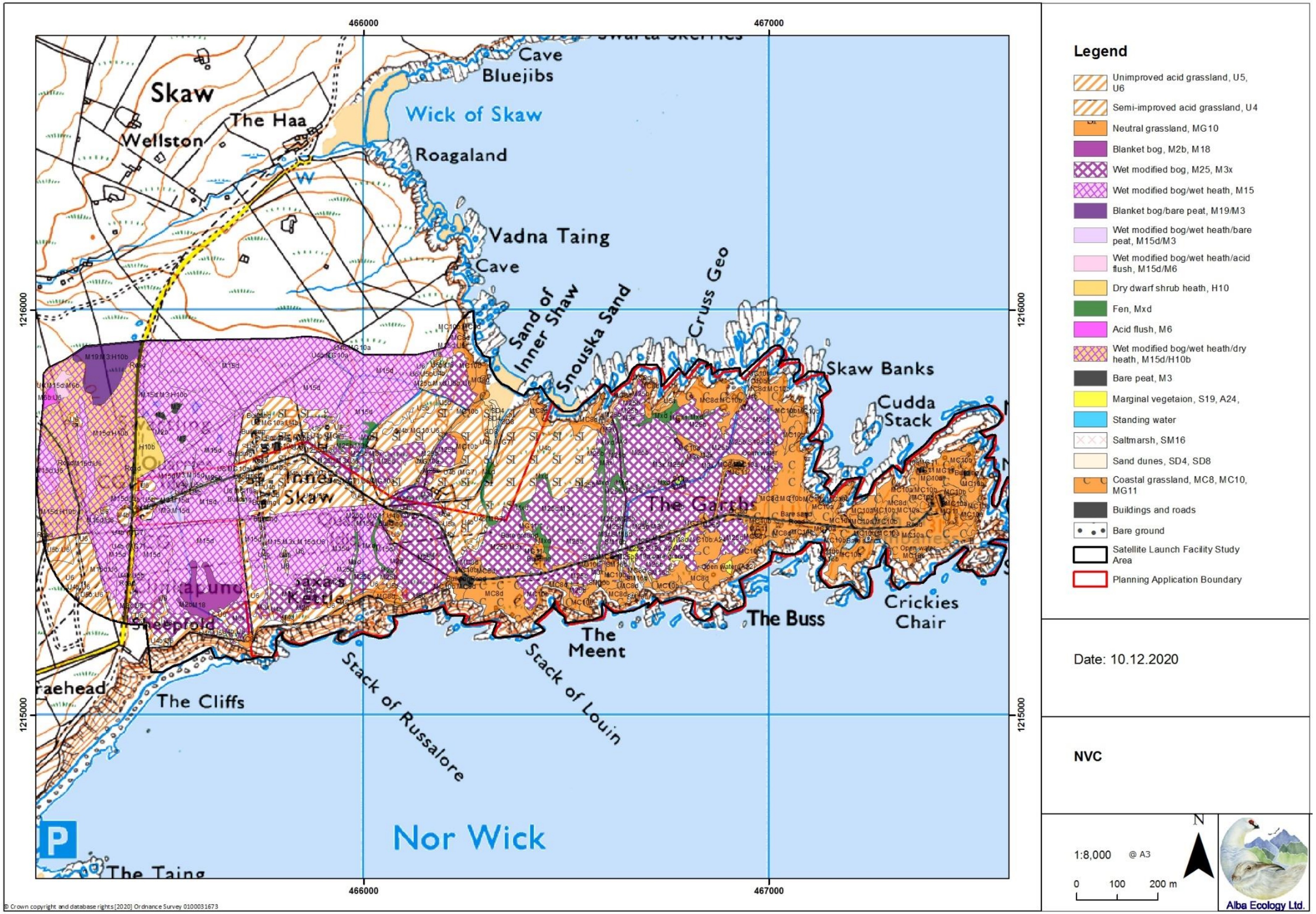
Photo 38: Field gentian (TG136).

Photo 39: The track way goes across dry dwarf shrub heath.

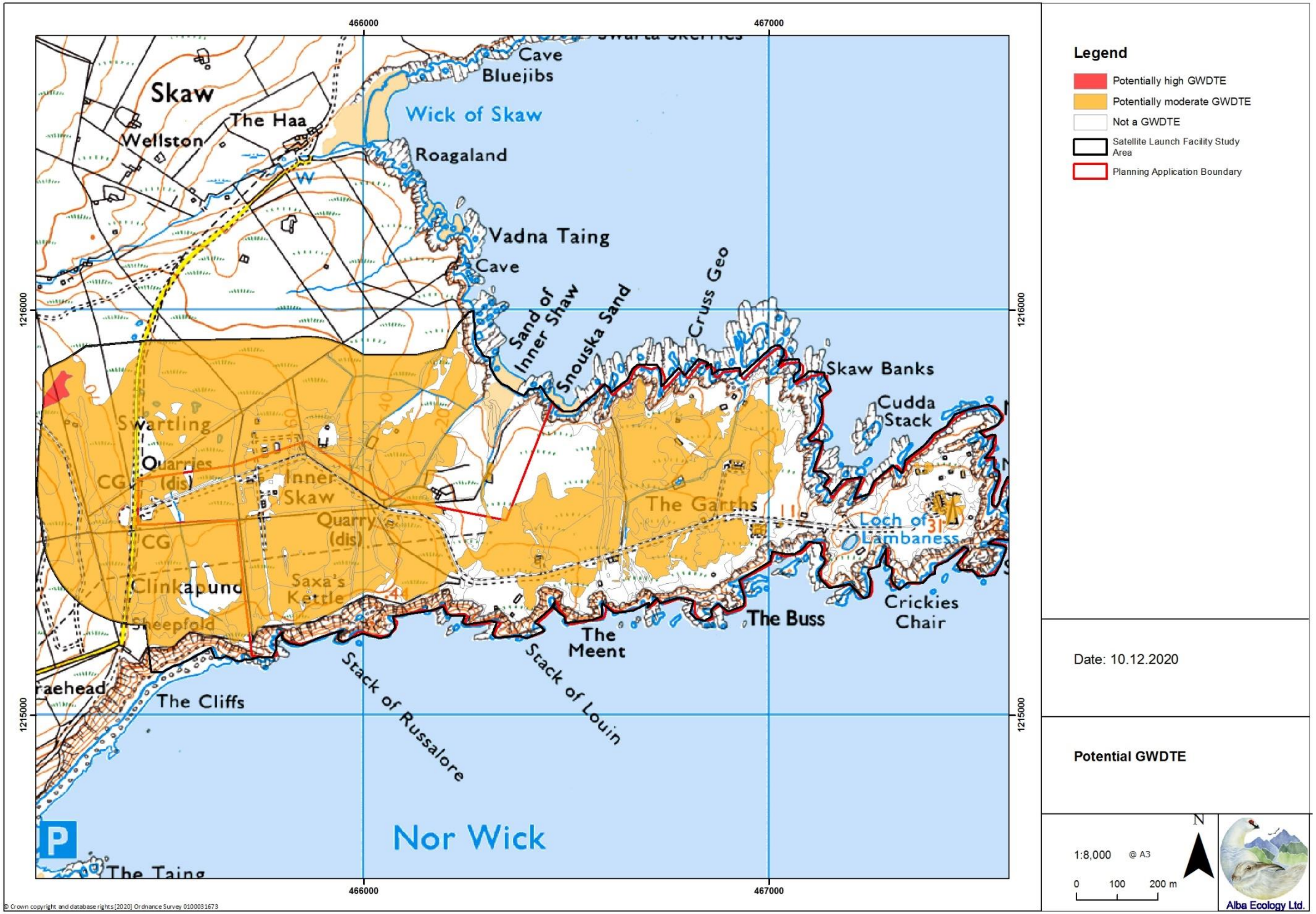
Photo 40: A rough neutral grassland within the Northdale Road Study Area.



Appendix 7.2 Drawing 3: Phase 1 Habitat Survey at the Satellite Launch Facility Study Area

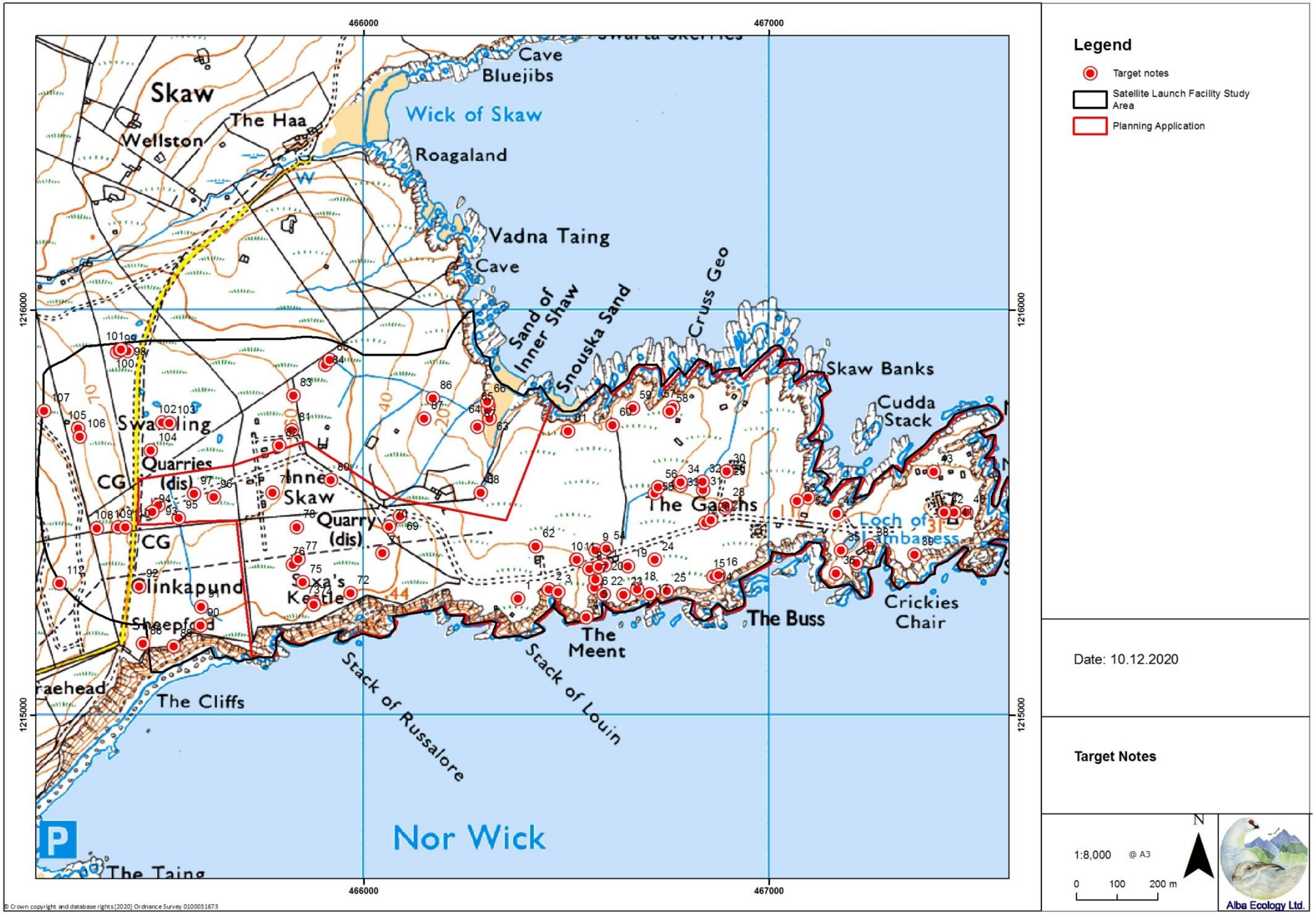


Appendix 7.2 Drawing 4: NVC communities at the Satellite Launch Facility Study Area

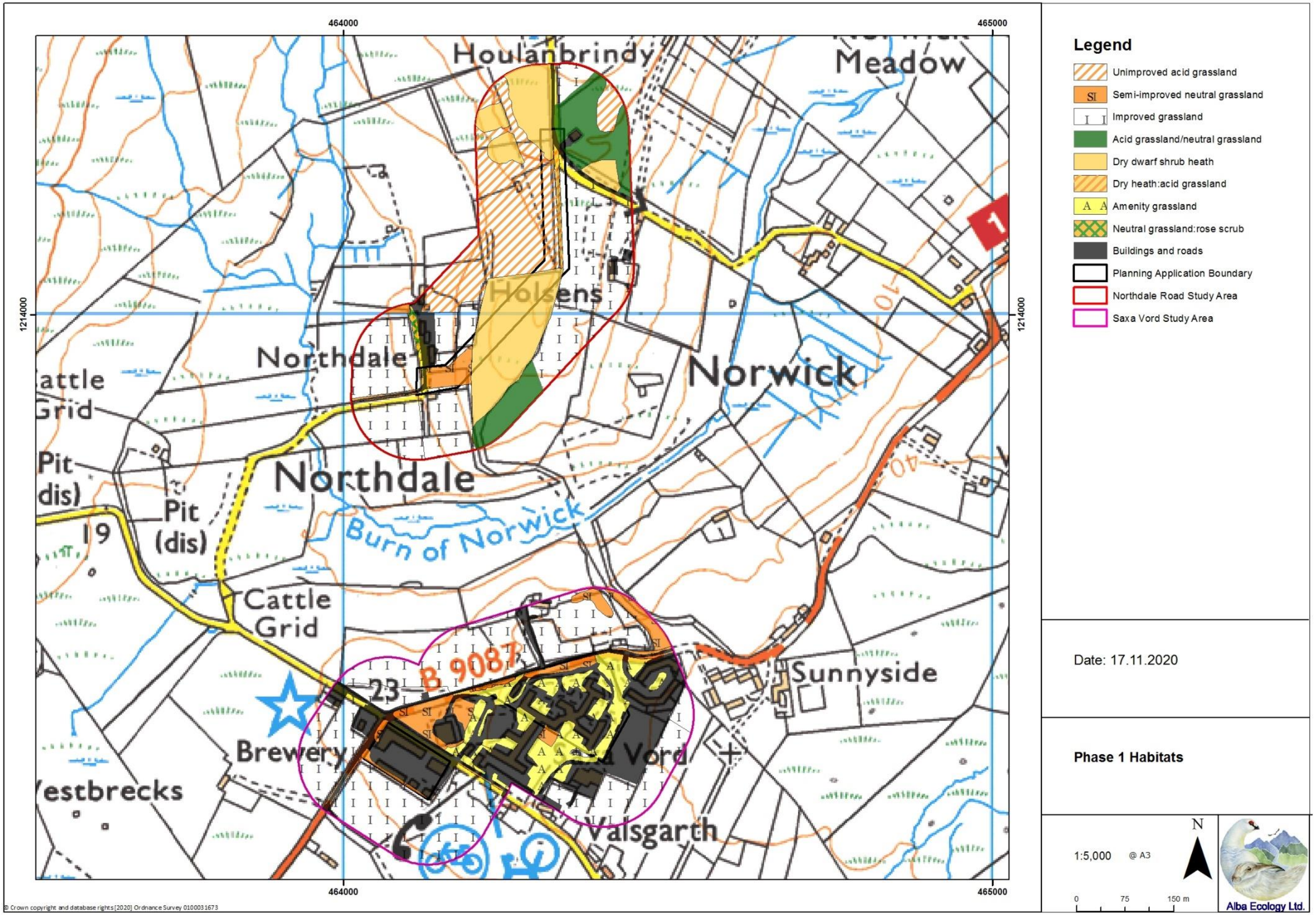


Appendix 7.2 Drawing 5: Potential GWDTEs at the Satellite Launch Facility Study Area

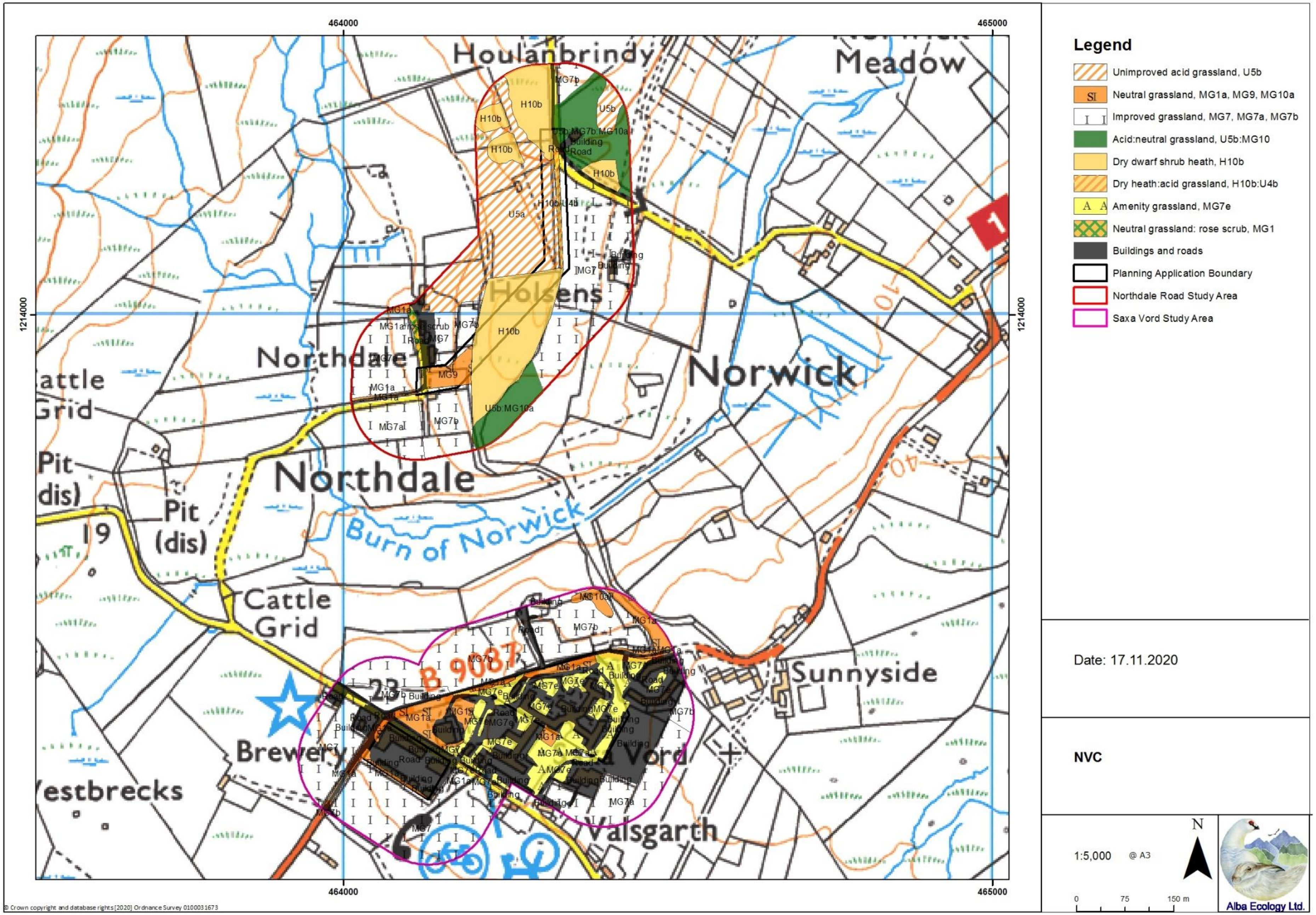
Appendix 7.2 Drawing 6: Peatland Condition at the Satellite Launch Facility Study Area



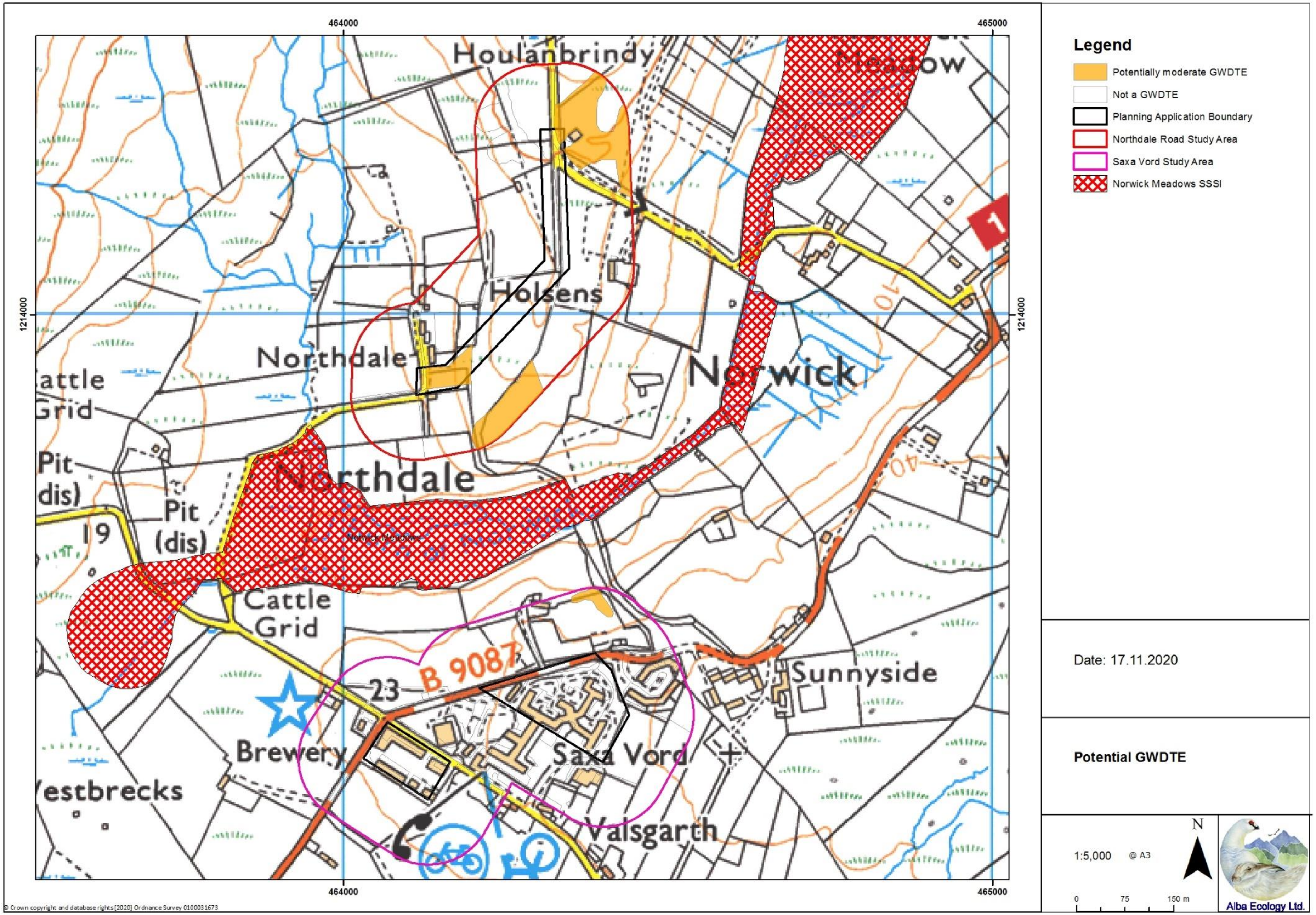
Appendix 7.2 Drawing 7: Target Note Locations at the Satellite Launch Facility Study Area



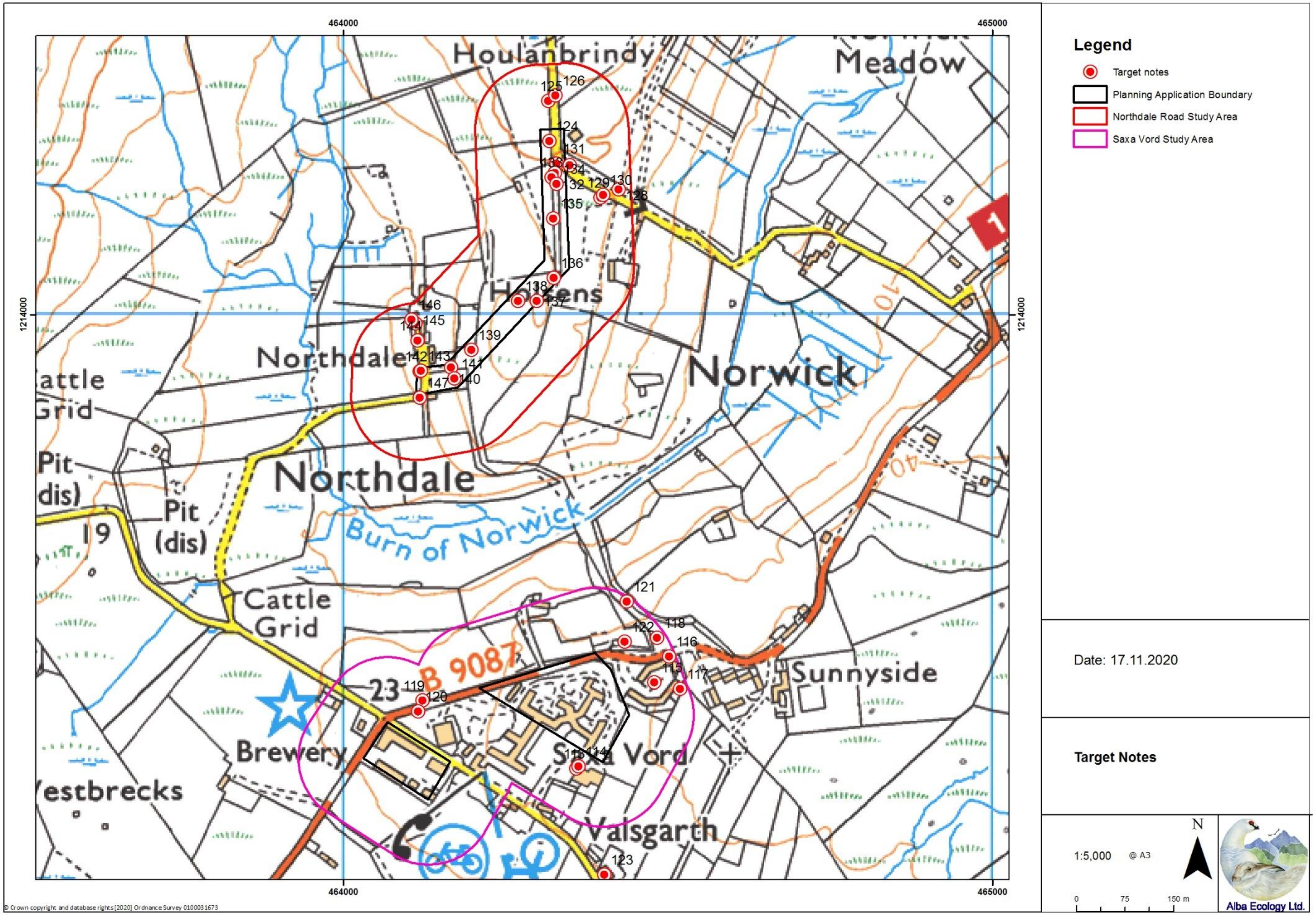
Appendix 7.2 Drawing 8: Phase 1 Habitat Survey at the Saxa Vord Study Area and Northdale Road Study Area



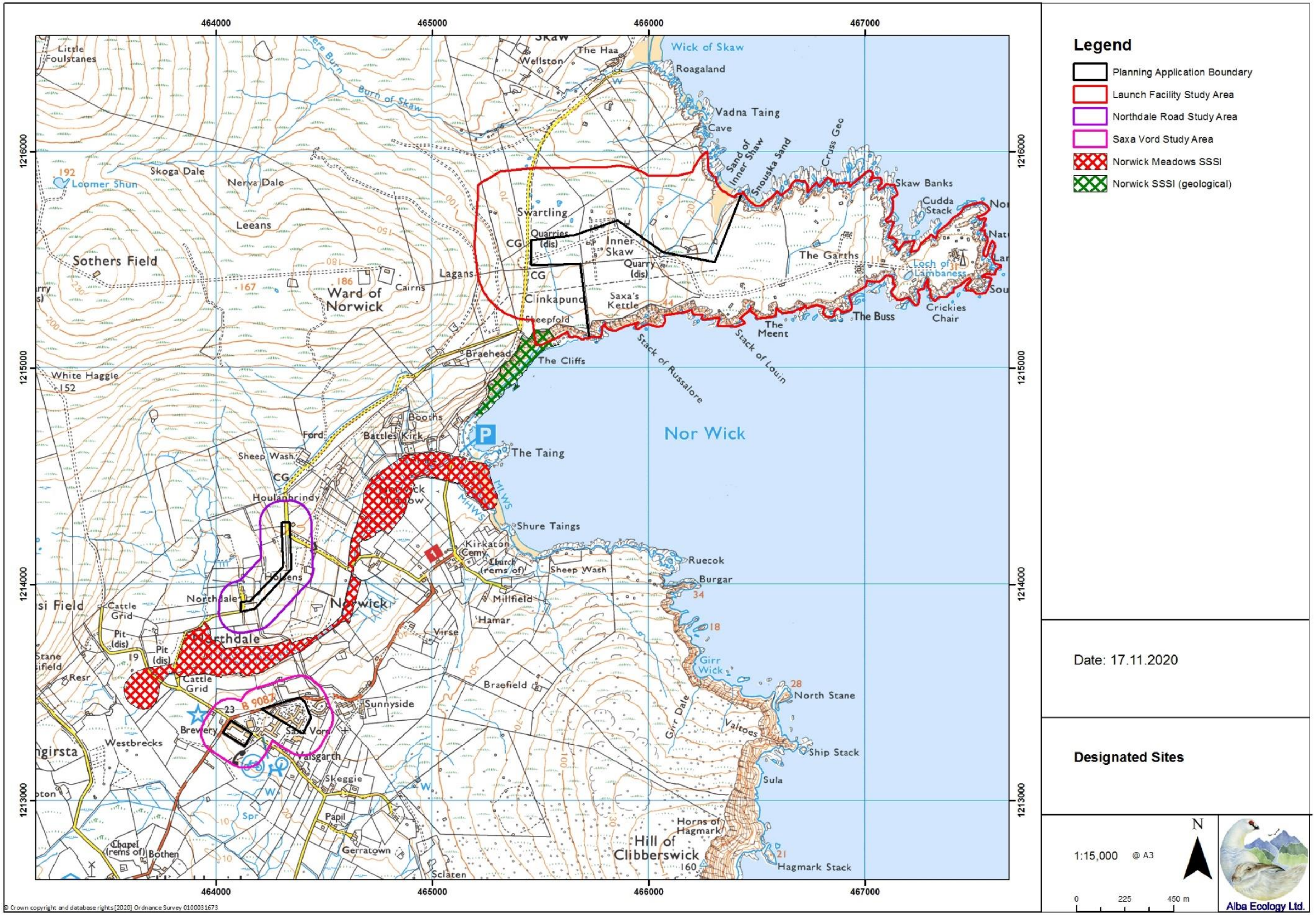
Appendix 7.2 Drawing 9: NVC communities at the Saxa Vord Study Area and Northdale Road Study Area



Appendix 7.2 Drawing 10: Potential GWDTEs at the Saxa Vord Study Area and Northdale Road Study Area



Appendix 7.2 Drawing 11: Target Note Locations at the Saxa Vord Study Area and Northdale Road Study Area



Appendix 7.2 Drawing 12: The location of the designated site, Norwick SSSI (geological) and Norwick Meadows SSSI in relation to the Study Areas

Appendix 6.3a SaxaVord Spaceport Otter Species Protection Plan March 2022

SaxaVord Spaceport Otter Protection Plan

Alba Ecology Ltd.

February 2022, Updated March 2022

This report should be quoted as '*Alba Ecology Ltd. (2022). Unst Space Port Otter Protection Plan*'.

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INTRODUCTION

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the '*SaxaVord Spaceport'*. As part of the proposal, Alba Ecology Ltd. was commissioned to produce this Otter Protection Plan as part of pre-commencement planning.

Otters are known to be present within the Planning Application Boundary area, which was surveyed in detail for otters in both 2018 and 2020. The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats within the Study Areas looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints).

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

According to NatureScot's standing guidance on otters (accessed 24/11/20), it is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;
- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection, or otherwise deny the animal use of that place;
- disturb an otter in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species; and
- disturb an otter in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

It is also an offence to:

- damage or destroy a breeding site or resting place of such an animal (whether or not deliberately or recklessly); and
- keep, transport, sell or exchange, or offer for sale or exchange any wild otter (or any part or derivative of one) obtained after 10 June 1994.

Otter shelters are legally protected whether or not an otter is present.

This means that if otters could be affected in these ways by a development, and no action is taken to prevent it, an offence may be committed. According to NatureScot "*Licensing allows named individuals to carry out actions that could otherwise constitute an offence. If you're planning any activities that could affect otters or the places they use, you must make sure you stay within the law*".

PREVIOUS SURVEY RESULTS

2018 data

Numerous otter field signs were recorded in the Proposed Launch Site Otter Study Area during targeted surveys in June 2018 (Table 1) and October 2018 (Table 2). Based on June 2018 survey data, there was a total of ten otter holts within the Proposed Launch Site Otter Study Area, six of which were in the Proposed Launch Site Boundary (EIAR Drawing 7.10). Based on October 2018 survey data, there was a total of eight otter holts within the Proposed Launch Site Otter Study Area with all but one of these in the Proposed Launch Site Boundary (EIAR Drawing 7.10). Based on the 2018 survey data, there were no otter holts within the Launch and Range Control Centre and New Section of Access Road at Northdale Otter Study Area (EIAR Drawing 7.11). Only spraints and footprints were recorded within the Launch and Range Control Centre and New Section of Access Road at Northdale Otter Study Area and these were adjacent to the Burn of Norwick.

Table 1. Otter signs June 2018

O/S grid reference	Type of otter sign	Note
HP6580215203	Holt	Obvious holt site with spraint at foot of cliff amongst boulder scree
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff - located from top
HP6649615366	Spraint/print	Small amount spraint but many fresh paw prints inside old concrete bunker
HP6667215410	Spraint	Spraint site with drying green by concrete found of old bunker and run leading to flash pool
HP6694415371	Holt	Active holts in boulder scree at foot of cliffs
HP6705015430	Holt	Recently active holt at top of cliff in boulder scree
HP6709915521	Spraint	Spraint site at old bunker
HP6718515489	Spraint	Active spraint site at bottom of cliff on boulder scree
HP6720315508	Spraint/run	Run leading from spraint point at foot of cliff across headland through underpass to the other side.
HP6762115529	Holt	Active boulder scree holt at foot day of cliff
HP6720815622	Spraint	Freshwater bathing pool active spraint site run from one side of headland to other
HP6707815936	Spraint	Active spraint site
HP6704215811	Spraint	Stream side spraint site, inactive
HP6702915769	Spraint	Stream side spraint site
HP6701415731	Spraint	Stream side spraint point active
HP6682215819	Holt	Active holt at foot of cliff boulder scree
HP6666915820	Run	Run up and down cliff from small geo leading up to small ditch
HP6630416163	Holt	Active boulder scree holt at foot of cliff
HP6634616188	Holt	Run across small headland provable holt below cliff top
HP6628316222	Holt, inactive	Clifftop holt, not recently active
HP6626616261	Holt, inactive	Clifftop holt, not recently active
HP6624416270	Spraint	Stream side spraint site
HP6475316325	Spraint	Stream side spraint point, just outside buffer zone
HP6451216235	Spraint	Stream side spraint site
HP6471814142	Spraint	Spraint point, bridge

HP6477814289	Spraint	Stream side spraint site
HP6483414368	Spraint	Stream side spraint site
HP6495114419	Spraint	Stream-side spraint point
HP6538914686	Spraint	Inactive spraint site
HP6524614816	Spraint	Inactive spraint site

Table 2. Otter signs, October 2018.

O/S grid reference	Type of otter sign	Note
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff- located from top
HP6647715340	Spraint/print	Currently inactive- spraint/paw prints in old bunker
HP6668815436	Spraint	Active spraint site
HP6696015377	Holt	Active holt in boulder scree bottom of cliffs
HP6705115430	Holt	Relatively active holt at top of cliff
HP6762115529	Holt	Active boulder scree holt at foot day of cliff
HP6754015606	Holt	Bunker used as holt v active
HP6754715719	Spraint	Active bunker spraint site
HP6724715610	Holt/lay-up	Boulder scree holt/lay-up
HP6720615630	Spraint	Active spraint site by stream and run across headland
HP6713915851	Spraint	Spraint at clifftop
HP6708915930	Spraint/lay-up	Active spraint site, lay-up
HP6701615730	Spraint	Active stream Spraint site
HP6681515845	Holt	Active hots in boulder scree foot of cliffs
HP6628416216	Print	Paw prints aside fresh dug holts but no spraint point (previously active) along clifftop
HP6623916259	Holt/spraint	Active spraint site by stream, relatively active holt on clifftop
HP6534214469	Tracks/spraint	Tracks and spraint on sand and at stream
HP6526314527	Spraint/print	Spraint site and paw prints along stream and beach
HP6521114661	Spraint	Very active spraint site by underpass - cub spraint noted confirming mother with family
HP6502514580	Spraint/print	Spraint and paw prints in mud by stream
HP6497714508	Spraint/print	Paw prints and spraint along stream- mum and cub sets together
HP6495214421	Spraint/print	Spraint and paw prints along stream- again cub prints with adult
HP6472914171	Spraint	Spraint site at underpass
HP6352014285	Spraint	Fresh spraint at roadside underpass
HP6385913627	Spraint	Fresh spraint site at underpass
HP6391513674	Spraint	Spraint site at underpass

2020 data

In July 2020, additional otter surveys were undertaken at the Proposed Launch Site Boundary. Numerous otter signs were recorded (EIAR Drawing 7.12, Table 3). This included eight holts located within boulder scree, below the cliff tops but above the high tide mark within the Proposed Launch Site Boundary. The holts were in inaccessible locations, between boulders or going into rock caves/crevices and were viewed from the cliff tops with binoculars (Photo 1). Scats and regularly used runs were recorded near and at the holt sites, and otters were occasionally seen/heard. One particular holt on Lamba Ness, which had a large build-up of scats, was clearly being used by a female and her young cubs in July 2020 (Photo 2).

Scats and footprints, including those of adults and young, were also recorded in the abandoned buildings across Lamba Ness (Photo 3). It was considered likely that some of the buildings were used as lay-ups during poor weather conditions, when holts at the base of cliffs would potentially be inundated with sea water.

Otter use of the existing track underpass at HP 671 154 was particularly noticeable. It was considered likely that otters use this underpass as a regular route to cross from the north to south side of Lamba Ness. The route was well delimitated on the grassland and rocks showing a well-established run (Photo 4). These data indicated that there was one female, with dependent young, using Lamba Ness as their core home territory. Regular sightings of a male indicated that Lamba Ness also formed part of at least one dog otter territory.

Table 3. Otter signs July 2020

O/S grid reference	Type of sign	Note
HP 66032 15254	Holt	Inaccessible holt within boulders of cliff face.
HP 66033 15255	Holt	Inaccessible holt within boulders of cliff face.
HP 66367 15253	Prints	Fresh footprints located within the small, abandoned building at this location.
HP 66764 15296	Holt	This holt was inactive in July 2020.
HP 66832 15296	Holt	This holt may have been active in July 2020. There were old & more recent spraints visible.
HP 66854 15291	Lay-up	The lay-up was in the boulder scree at this location.
HP 67046 15425	Holt	There was a holt at this location, within the boulder scree.
HP 67091 15465	Run	The underpass showed signs of frequent use by otters. There was a clear run from the rocks to the underpass.
HP 67510 15446	Lay-up & run	A commonly used lay-up & run within the rocks of the edge of the cliff.
HP 67530 15451	Holt	Potential holt site. Appears inactive this season.
HP 67431 15532	Spraint/print	This abandoned building had many signs of otter use including spraints & footprints. It is likely used as a couch.
HP 67439 15637	Prints	There were otter footprints in this abandoned building. The prints were of two different sizes, indicating a female & young.
HP 67136 15532	Holt	This was the most active holt in 2020. There was a large pile of spraints which included crab remains. Crabs are easy kills for young otters. This holt was likely to have a female with young.
HP 66740 15785	Holt	Potential holt. Spraints recorded here.

Example photos (from 2020 and 2022)

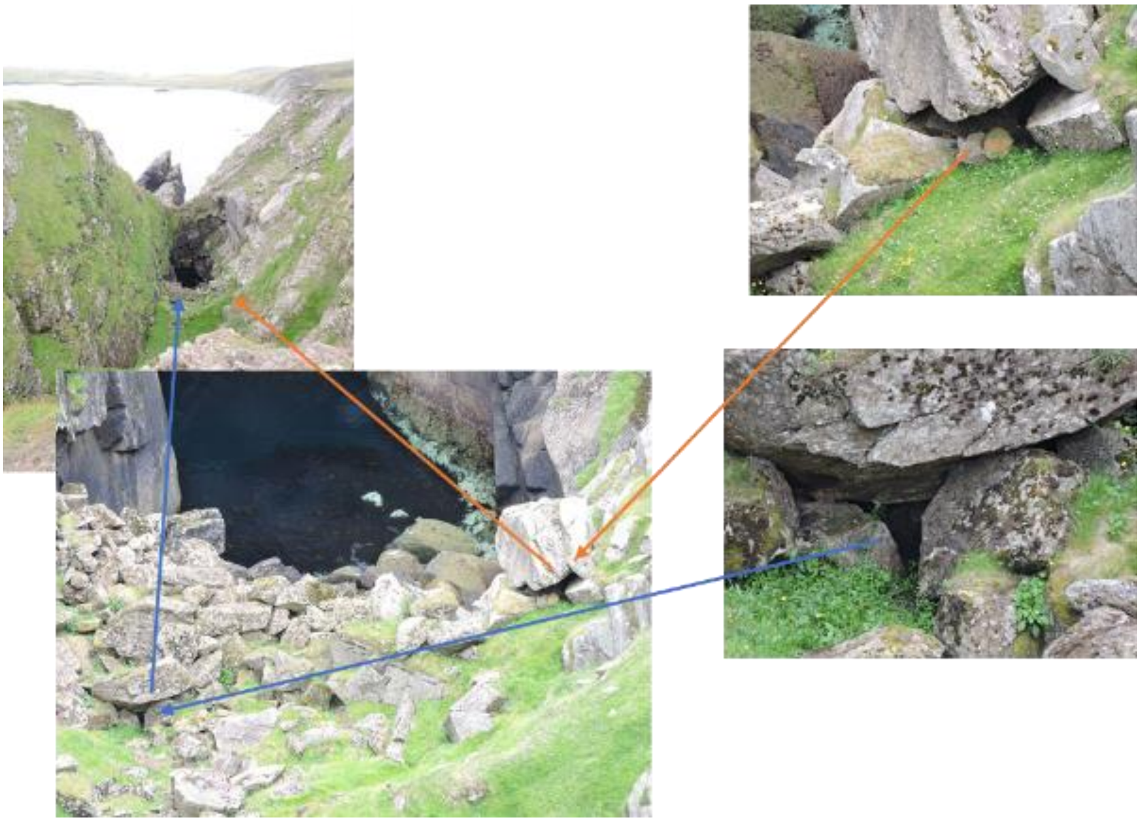

Photo 1: Two inaccessible otter holts were viewed from the cliff top. They were located within boulder scree. Spraint marks around the entrances were evident (OS grid reference HP 66032 15254), as was flattened vegetation.

Photo 2: The most active holt location was likely used by a female with young. The spraint pile nearby was very fresh and included crab remains (OS grid reference HP 67136 15532).

Photo 3: Fresh otter prints, of two different sizes, were clear within this abandoned military building (OS grid reference HP 67439 15637).

Photo 4: A clearly defined otter run (slightly dark coloured curved area of grass in the foreground) going towards and through the track underpass (OS grid reference HP 67091 15465).

Photo 5. Clearly defined otter run on the north side of track underpass (OS grid reference HP 67091 15465) to a small freshwater pool. Based on field signs, this pool is regularly used by otters to clean themselves after leaving saltwater.

There is evidence that the Proposed Launch Site Boundary is regularly and indeed heavily used by otters (e.g. EIAR Drawing 7.10 and 7.12). The presence of multiple holts and lay-up sites within the Application Boundary and other signs means that otters could potentially be directly affected by the proposed development.

Based on the indicative planned site layout and the most up to date (July 2020) otter survey data, the main sensitivities are considered to be:

- The access road bend by the Satellite Tracking Station is relatively close to an otter holt (ca. 240m separation).
- Launch Pad 1 is close to an otter holt (ca. 30m separation).

- The access road between Launch Pad 2 and Launch Pad 3 is close to two otter holts (ca. 55m south and 80m north separation) and crosses the otter run.
- Launch Pad 3 is situated on buildings used by otters and is close to an otter holt at the end of Lamba Ness (ca. 100m separation).

There is no evidence that the proposed development at the proposed Launch and Range Control Centre and proposed New Section of Access Road would impact on any otter breeding site or resting place (e.g. EIAR Drawing 7.11). Otter use of this area appears occasional and is focussed along the Burn of Norwick. Consequently, it is unlikely that proposed development in the Launch and Range Control Centre and New Section of Access Road Otter Study Area would kill, injure, capture or disturb an otter whilst it is occupying a holt or other places of rest/shelter. This assumes that best practice construction methods are employed under the supervision of an Ecological Clerk of Works.

The EIAR recognises that otters could be directly affected by the Proposed Launch Site (i.e. the planned work could potentially kill, injure, capture or disturb an otter whilst it is occupying a holt or other places of rest/shelter) and so an Otter Species Protection Plan is necessary. Figure 1 illustrates the known legally protected otter features across the Site based on 2018-2020 data.

Figure 1. Known Otter Constraints 2018-2020.

MINIMISING IMPACTS

There is a good understanding of how otters at Lamba Ness use the habitats present with many holts at the base of sea cliffs and used during suitable weather (e.g. Photos 1-2). During inclement weather (e.g. winter storms), some of these holts would potentially be inundated with sea water. At such times, the otters probably make regular use of the old abandoned open military buildings which become *de faco* holts/resting places (e.g. Photo 3). Any development related work on these buildings must therefore be considered as potentially affecting resting/holt sites. It should be noted that fresh otter footprints inside buildings were recorded in July 2020 during a period of good weather, suggesting the building may also offer shelter outwith adverse weather conditions. It may be that natural resting/holt sites in the Proposed Launch Site Boundary (away from the base of cliffs) are limited and are therefore perhaps used year-round.

The track underpass (Photo 4) is also an important feature for otters, allowing them to cross from one side of Lamba Ness to the other, (bathing/cleaning in the freshwater pool - Photo 5) without having to swim around the point or cross a large area of open ground and an access track. This feature might be extremely important functionally, particularly during inclement weather and it should be treated as such in construction plans (e.g. CEMP).

The measures within this Otter Protection Plan follow the well-established hierarchy of avoidance, mitigation and compensation as outlined in the actions in Table 4. It is important to recognise that otter use of the Site may vary over time and planned actions will need to account for this. Consequently, the Otter Protection Plan Actions (Table 4) should be regularly reviewed to ensure they are fit for purpose and this document should remain ‘live’ and be updated by the ECoW when necessary.

Table 4. Otter Protection Plan Actions

Action	Location	Comments
Tool-box talk & construction site materials.	Site Office	Construction workers & site staff must be given a tool-box talk (provided by the ECoW) which covers otter species protection issues. Sensitive & legally protected otter features must be marked-up on relevant construction plans & updated in light of new information.
Create otter sensitive zones.	Holts, couches & underpass/ pool area	Physically mark sensitive areas on the ground using coloured pegs & possibly rope/line marker chalk paint. It should be recognised that standard canes & marker tape typically used to mark-up sensitive areas might get damaged & blown away by strong winds. Therefore, strong, low markers, fixed securely into the ground or marked directly onto the ground with line marker chalk paint will likely be most resilient to adverse weather conditions.
Pre-construction survey	Site wide	Pre-construction surveys for signs of otters was undertaken in march 2022 prior to any works commencing on the Proposed Development.
All construction work must avoid damage &/or destruction of otter holts/couches unless under licence from NatureScot.	Site wide	Construction plans avoid damage &/or destruction of natural otter holts/couches, most of which lie at the base of sea cliffs & so will be unaffected (Figure 1). In the 2020 otter surveys one existing building, in the east of the Site at proposed Launch Pad 3, had evidence of use

		by otters and was identified as being directly lost by the construction of the Proposed Development. At the single, known otter resting place, where avoidance is not possible, a pre-construction survey was carried out. In the pre-construction otter survey all the existing buildings on Lamba Ness were surveyed. One existing building, in the east of the Site at proposed Launch Pad 3, had evidence of use by otters in March 2022 and will be directly lost by the construction of the Proposed Development.  *Footprints of an individual otter were recorded in a building within the development footprint at HP6743915639.* This area was identified as a couch. Couches are daytime resting places for otters. Therefore, the destruction/modification of this building will require a licence from NatureScot. While no other resting places will be destroyed given current information, the ECoW will provide regular inspections/surveys of the buildings and note any change in use of the buildings by otters. Artificial holts/shelter will be used to replace the lost spaces in the building at a very similar nearby location providing alternative resting sites.
Retain the established and well used run, underpass & freshwater pool (Photos 4 & 5).	HP 671 154	The vehicle track running on top of the underpass will need strengthening & widening. As a consequence, the existing underpass will be extended & an additional tunnel added to facilitate crossings if the existing tunnel is inundated during wet weather. The well-used run & freshwater pool will be retained to maintain important connectivity between the north & south sides of Lamba Ness. Every effort will be made to ensure the underpass and runs to and from the underpass are not destroyed or obstructed though the construction period. This will be achieved by:

		• The underpass will remain open during the construction phase, as far as possible. • The route of the run will be avoided, with exclusion zones marked and not entered unnecessarily. • Either side of the underpasses will have an artificial holt/shelter designed into it, so otters can use them for refuge.
Avoid working in vicinity of otter holts/couches in the hours darkness.	Site wide	Unlike on the mainland, otters using coastal habitats on Unst are diurnal & so not limited to nocturnal or crepuscular hunting/feeding.
Avoid disturbance to otter holts/couches.	Site wide	Mark work exclusion zones around any holts & shelters. If otters are breeding, the disturbance-free zone should be at least 200m. However, it could be reduced to 100m depending on the nature of the works, topography & natural screening. This will require judgement from an experienced ecologist. For holts & shelters where otters are not breeding, the exclusion zone should be 30m. Where exclusion zones of the required size are not possible, works will require a licence from NatureScot before they can proceed. 30m exclusion zones will be maintained around the three active holt locations identified in March 2022. These are shown in Figure 3. The proposed works are all outwith 30m. The holts were located within inaccessible boulder scree at the base of sea cliff. They were viewed with binoculars from safe locations from the top of the cliffs. Therefore, some of the grid references are indicative, and are likely further away than shown. As the Lamba Ness peninsula is actively used by otters, the construction team and the Ecological Clerk of Works should be aware of, and keep a watching brief for their presence, especially when working in and around the old military buildings and at/around the underpass.
Cap exposed pipes when not in use.	Site wide	All exposed pipes must be capped to prevent otters from entering them & potentially getting injured/killed. See example photo below.

		
Enforce safe-working vehicle speed limit.	Site wide	Vehicle speed limit of 10 mph across the Site to reduce possibility of otter traffic mortality/injury.
Awareness raising for drivers.	Entrance & main track	Otter crossing road signs will be located at the Site entrance & at other strategic locations along the main track, including either side of bridge with the otter underpass.
Construct ten artificial holts to replace any natural holts/couches that have to be destroyed or damaged.	Site wide	None of the natural holt sites will be directly lost due to construction as they were all recorded in inaccessible locations in the boulder scree and caves at the foot of cliffs which are deliberately avoided by the design layout. The construction of the Proposed Development will result in the direct loss of ten abandoned military buildings/ruined infrastructure, including one that is known to be used by otters (and considered above) and an additional nine abandoned military buildings/ruined infrastructure. There is no evidence that these nine locations have been used as resting places by otters from previous surveys. However, otters are mobile and so occasional use cannot be ruled out. Therefore, pre-construction otter surveys will be required. To mitigate for the loss of potentially occasionally used shelter a series of artificial otter holts will be built as identified in Figure 2 to provide additional resting places away from the coast.

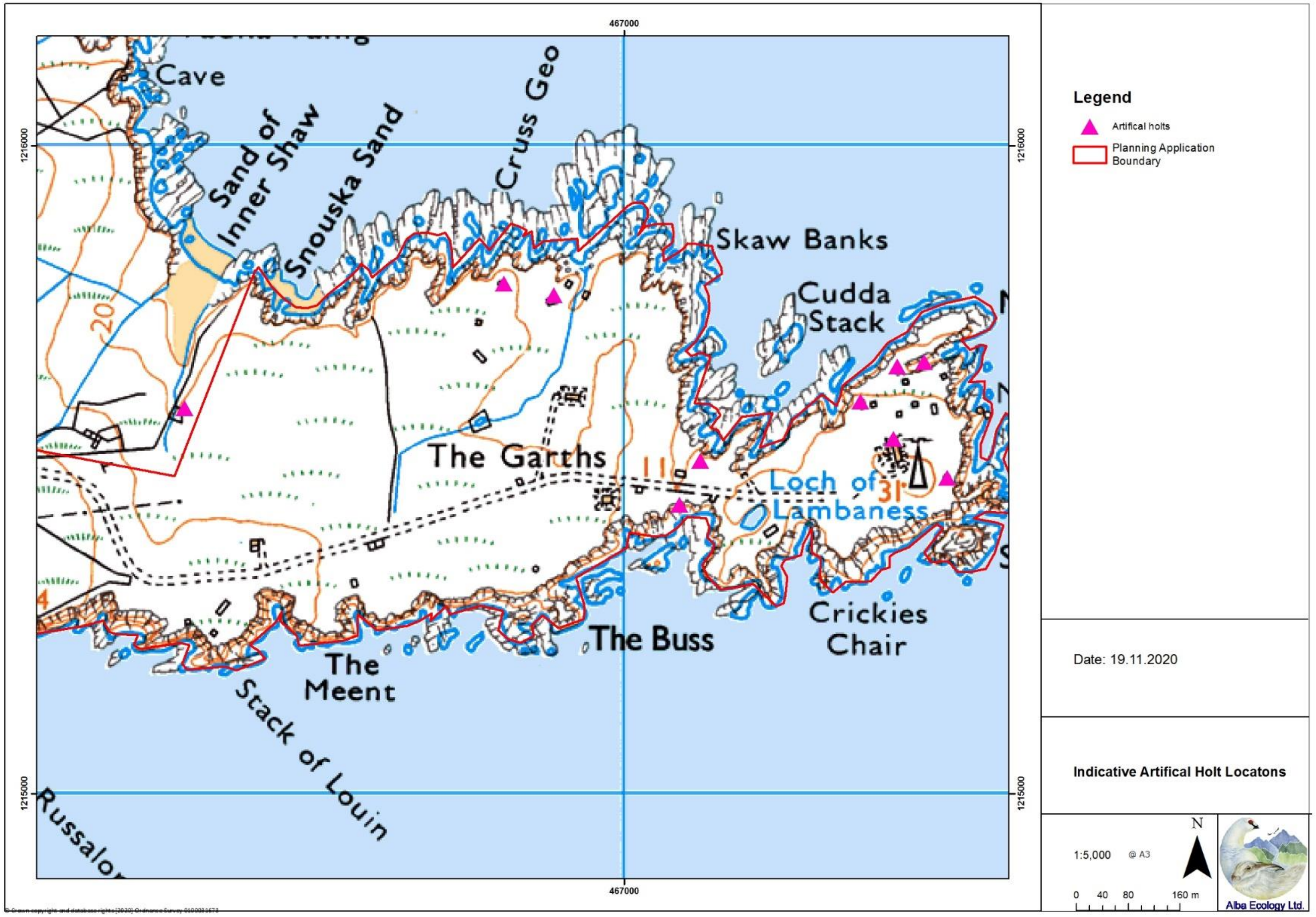

Figure 2. Artificial Otter Holt Locations.

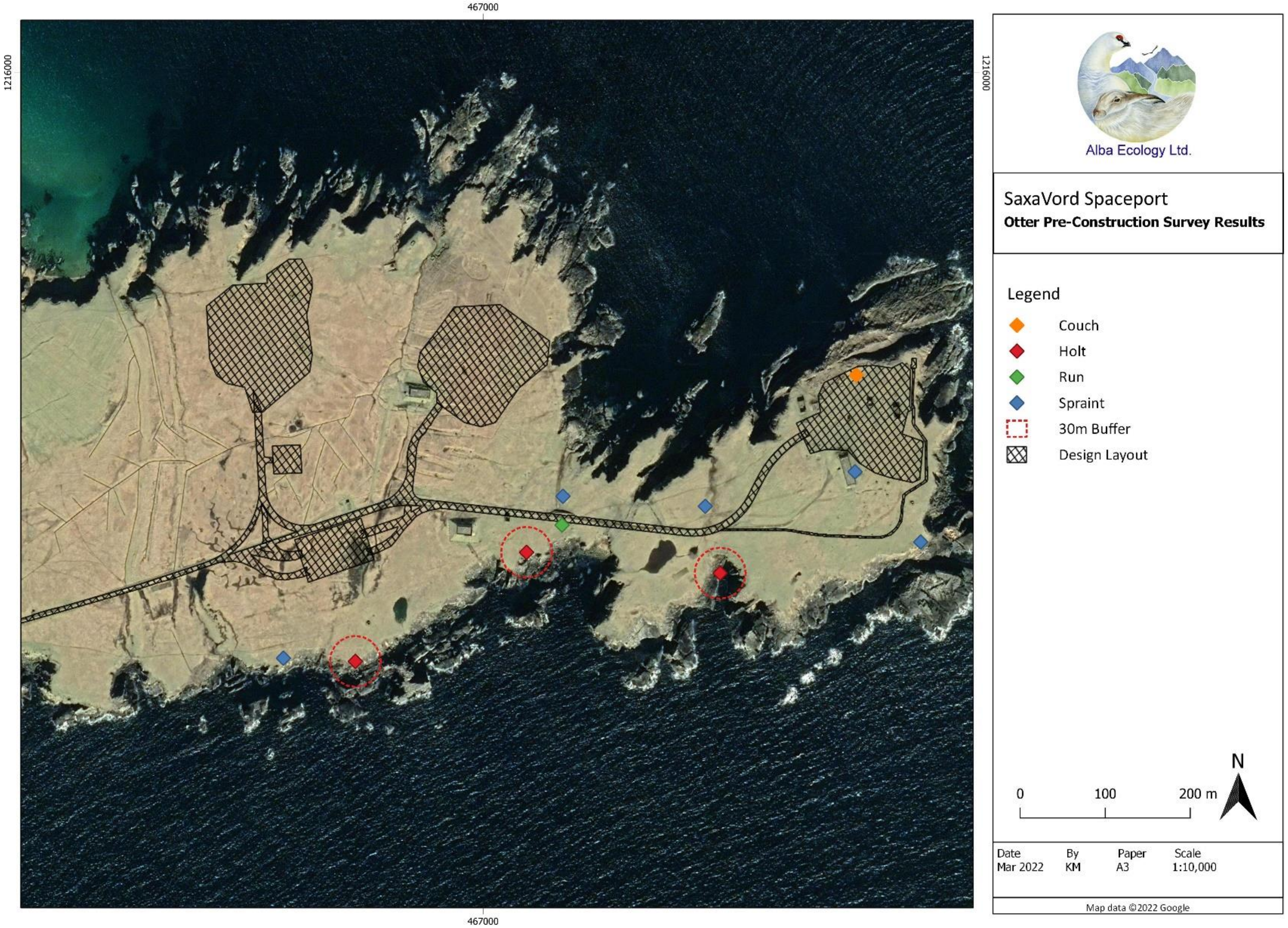

Figure 3. 30m buffer around holt locations.

Licensing development works affecting otters

Licences for development works that would otherwise result in an offence with respect to EPS such as otters, can only be issued if it can be demonstrated that the following three tests are all met:

- Test 1 - that the purpose of the licence is to preserve public health or public safety or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.
- Test 2 - that there is no satisfactory alternative.
- Test 3 – that the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

There is a presumption against licensing disturbance to breeding otters and damage or destruction of an otter holt while being used for breeding. Nevertheless, according to the NatureScot standing advice "*developers can apply for a licence to allow proposed development works that might affect otters to proceed legally*". An example of the type of information likely to be require for licencing is provided in Annex 1.

For all development proposals where otters are a consideration, pre-construction surveys should be timetabled into project plans. This is to enable checks for any new holts or resting places that may have become occupied after the original surveys, and to ensure the measures proposed to minimise impacts on otters remain appropriate. Consequently, a pre-construction otter survey will need to take place within 4-6 weeks of constructions works commencing.

REFERENCES

Chanin P. (2003) Monitoring the otter *Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No.10. English Nature, Peterborough.

NatureScot (no date) Standing Advice for Planning Consultants. Protected Species: Otter. Otters: licences for development | NatureScot [accessed February 2022].

ANNEX 1. Example of Likely Otter Licensing Requirements

Introduction

A proposal for a satellite launch facility has been made by the Applicant in north Unst, Shetland - known as the 'Unst Space Port'. Targeted otter surveys (2018-2020) demonstrated that the Proposed Launch Site Boundary is regularly used by otters. Chapter 7 of the Environmental Impact Assessment Report (EIAR), identified that the proposals would potentially result in the destruction of a single occasionally used otter resting place within an abandoned military building on Lamba Ness. The destruction of the resting place of an EPS, such as an otter, is an offence unless licensed. Construction work on this military building will therefore require a licence from NatureScot to destroy this shelter if it is still used being otters.

This Annex provides an outline of the likely licensing requirements and obligations and the information required for the licence application.

Legal protection

The Eurasian otter (*Lutra lutra*) is an EPS under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). According to NatureScot's standing guidance on otters, it is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;
- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection, or otherwise deny the animal use of that place;
- disturb an otter in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species; and
- disturb an otter in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

It is also an offence to:

- damage or destroy a breeding site or resting place of such an animal (whether or not deliberately or recklessly); and
- keep, transport, sell or exchange, or offer for sale or exchange any wild otter (or any part or derivative of one) obtained after 10 June 1994.

Otter shelters are legally protected whether or not an otter is present.

Licencing

NatureScot is responsible for considering and issuing licences to permit actions related to developments that might affect EPS, such as otters. A licence allows activities to be carried out which would otherwise be unlawful. Licences are granted subject to conditions and licence holders are responsible for ensuring compliance with conditions. Failure to comply with conditions is an offence.

Applications for a licence should be made to NatureScot for work that could otherwise result in an offence in relation to otters. The Application form and accompanying guidance is on the NatureScot webpage at: Otters: licences for development | NatureScot [accessed February 2022].

Avoiding the Need for a Licence

When considering activities that could affect otters the primary aim is to avoid impacts in the first place. Given that otter use of an area changes over time, it is important that up to date information (in the form of a pre-construction otter survey and report) is available and used to inform whether a licence is needed or not.

Offences and impacts can be avoided in a number of ways, such as;

- modifying the location of a proposed action/piece of work;
- timing operations to avoid times when the species is likely to be present;
- protecting important features from disturbance by creating ‘no disturbance zones’;
- retaining certain areas/structures used by the species;
- modifying working practices; and
- look at alternative solutions to problems.

If there are no satisfactory alternatives to avoiding an impact/offence, a licence may be necessary. If this is the case the applicant will need to clearly demonstrate the alternatives that have been considered and why they are not satisfactory.

Tests for Granting a Licence

A licence can only be granted if the three strict EPS licensing tests are met.

- Test 1 - that the purpose of the licence is to preserve public health or public safety or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.
- Test 2 - that there is no satisfactory alternative.
- Test 3 – that the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

Supporting Information

In order to apply for a licence, supporting information must be provided by the Applicant to the licensing authority (NatureScot in this instance). NatureScot provides guidance on the supporting information needed (*Guidance notes on providing supporting information for a licence for European protected species*).

The supporting information includes:

- Survey and site assessment (in the form of an up-to-date pre-construction survey report);
- Impact assessment, mitigation and compensation;
- Method statement; and
- Appropriate maps.

It is the responsibility of the Applicant to demonstrate (and provide supporting evidence where necessary) why the proposal (in its submitted form) is necessary. The Applicant should explain any alternatives that were considered and justify why these were discounted. The application should provide objective evidence of a lack of satisfactory alternatives. Applicants will need to provide detailed proposals of all the mitigation and compensation measures that they will undertake to ensure that impacts on the species concerned are minimised.

The Species Protection Plan should outline the measurers that planned to mitigate/compensate for the otter feature(s) that may be lost through construction and be provided to NatureScot. The Species Protection Plan should allow NatureScot to consider the merits and potential efficacy of the measures proposed to reduce impacts on otters.

Outline rationale for the Licence Application

Based on existing information, the construction of the Unst Space Port has the potential to adversely impact otters in one way; through the destruction of a single known resting place (an old abandoned military building). This activity is likely to require an agreement with, and a licence from, NatureScot.

Avoidance

Avoidance of impacts on otters was achieved through in-built design in several ways. For example:

- The cliffs and their bases (where most otter holts were identified) have been avoided by the design layout, therefore the majority of the otter holt locations will not be directly impacted by any land-take.
- Two out of three of the old military buildings known to be used by otters have been avoided by the design layout.

- An important under-road culvert, which is regularly used by otters crossing overland from one side of Lamba Ness to the other will be retained (and extended).

Additional Mitigation in Relation to Otters

To further avoid and minimise impacts on otters additional mitigation will be undertaken in relation to the Proposed Development:

- An Ecological Clark of Works (ECoW) will ensure that pipes etc. are stored correctly reducing likelihood of otters using them and being present in potentially 'high risk' areas during construction.
- Enforced low vehicle speed limits (10mph) would greatly reduce the likelihood of injury or death from vehicle collisions happening during construction. Similarly, low enforced vehicle speed limits (10mph) during operation would greatly reduce the likelihood of any operational mortality.
- Otter crossing road signs will be located at the Site entrance and at the frequently used otter run to further help prevent mortality caused by vehicle traffic during construction and operation.
- The frequently used otter run, crossing from the north to south of Lamba Ness and using the underpass at HP 671 154 has the potential to be damaged or destroyed during construction. The road will be reinforced and widened at this location for access. However, the design will deliberately be otter friendly. The current underpass will remain and will be extended on either side. As the road will be reinforced and widened at this location an additional underpass will also be created, slightly above and along from the current location. This will provide an alternative, easy route for otter if, for example there is any period of heavy rain causing flooding/puddling of the current underpass or if it gets blocked for any reason. Either side of the underpasses will have an artificial holt/shelter built (Figure 2), so otters can use them for refuge.
- Fencing around the Proposed Development has the potential to impede otter movements to and from the buildings. It is also possible that otters may want to occasionally cross the site during construction and operation at other locations. To avoid blocking potential routes, and as part of embedded mitigation, permeable (otter friendly) boundary fences will be used during construction and operation. They will be otter friendly in-so-far as they will have regular small gaps for otter to move through. The spacing of gaps along the fence will be agreed with NatureScot and will form part of the otter licencing/planning conditions.

Predicted Impacts of the Proposed Development and Mitigation

Despite the avoidance and mitigation outlined above, the construction of the Unst Space Port would likely result in the unavoidable destruction/modification of a resting place/holt within a single abandoned military building around the area of Launch Pad 3 (EIAR Chapter 7). Targeted otter surveys showed that this building has been occasionally used in the past as a resting place by otters. Assuming pre-construction surveys demonstrate that the building is still used, the destruction/modification of this building will require a licence from NatureScot.

While no other resting places will be destroyed given current information, pre-construction surveys will assess whether any of the other areas or buildings which will be lost during construction are used by otters.

Nine artificial holts/shelters (Figure 2) will be created across the top of the Lamba Ness area (in which the current use by otters appears limited). These include two at either side of the regularly used underpass. These should provide appropriate multiple alternative resting sites in lieu of the old military building. This mitigation will be embedded within the planning conditions and will be constructed prior to the works on the military buildings commencing.

Application and Supporting Information for Licence Application

To apply for a NatureScot otter licence the Applicant will provide an application form detailing:

- That the purpose of the licence is of a social/economic nature;
- That there were no satisfactory alternatives; and
- That the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

To support the licence application the Applicant will provide:

- Appendix 7.3: Otter Survey Report;
- EIAR Chapter 7: Ecology;
- Appendix 6.4 OHMP;
- An up to date pre-construction otter survey of the abandoned military buildings; and
- A method statement outlining details of the works and associated mitigation.

The methods statement and pre-construction otter survey will be written post-consent and submitted as part of the licence application.

Appendix 6.3b SaxaVord Spaceport Pre-Construction Otter Survey Report

SaxaVord Spaceport Pre-construction Otter Survey Report

Alba Ecology Ltd.

March 2022

This report should be quoted as '*Alba Ecology (2022). SaxaVord Spaceport Pre-construction Otter Survey Report 2022*'.

Registered Office: Coilintra House, High Street, Grantown on Spey, Moray PH26 3EN Tel: 01479 870238. *enquires@albaecology.co.uk*

Introduction

An application for a satellite launch facility has been made by SaxaVord Spaceport in north Unst, Shetland (formerly known as the Shetland Space Centre). Planning permission was granted in March 2022.

Previous surveys of the area in support of the initial application (Alba Ecology, 2020a) found numerous otter signs, and use of some of the buildings present on the Lamba Ness peninsula. As part of the planning conditions, Alba Ecology Ltd. was commissioned to conduct a pre-construction otter survey targeted around the site works of the launch facilities at Lamba Ness. This was to provide up-to-date information of the current use of the area by otters.

Aim

The aim of the SaxaVord Spaceport pre-construction otter survey was:

- To provide up-to-date information and inform the SaxaVord Spaceport development on the current use of the area by otters; and
- To provide advice in regard to the requirement of a licence from NatureScot to undertake construction work.

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). It is therefore an offence to deliberately or recklessly:

- Kill, injure, capture or harass an otter;
- Disturb an otter whilst it is occupying a holt (underground den) or other place it uses for shelter or protection, or while it is rearing or otherwise caring for its young, or in any way that impairs its ability to survive or breed, or significantly affects the local distribution or abundance of otters; and
- Obstruct access to an otter breeding site or resting place, or otherwise prevent their use.

And whether or not deliberate or reckless:

- To damage or destroy an otter breeding site or resting place.

This means that if otters could be affected in these ways by a development, and no action is taken to prevent it, an offence may be committed.

Methods

Surveyor

According to the NatureScot otter standing guidance "*surveys should be done by persons with the appropriate knowledge of otter ecology and practical experience of otter survey work*"(NatureScot, 2020). The Study Area was surveyed for otters in March 2022 by Mr Donald Shields MCIEEM, a highly experienced mammal surveyor and ecologist. Mr Donald Shields has the knowledge, skills and experience required to survey, disturb and/or to carry out research works on otter in accordance with the CIEEM (2013) '*Competencies for Species Survey: Eurasian Otter*'.

Study Area

The Study Area was based on two factors: The first was the design layout of the development at Lamba Ness (Figure 1), and the second, where otter signs were recorded in previous surveys.

NatureScot's standing guidance (2020) states that "*Surveys should be done by persons with the appropriate knowledge of otter ecology and practical experience of otter survey work. All suitable otter habitat within 200m of the proposed works should be surveyed, including a systematic search for spraints, paw prints, otter paths, slides, food remains, holts and places used for shelter*". This is in accordance with general best practice guidance e.g. Chanin (2003). As a consequence of this guidance, outwith the footprint of the design layout, a 200m buffer was also surveyed for signs of otter, and termed the Study Area.

Figure 1: *Lamba Ness with SaxaVord Spaceport (Shetland Space Centre) design layout*

Survey methodology

As a pre-construction survey, this was conducted just prior to the planned commencement of construction works on the project.

The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats within the Study Area looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints) (Chanin, 2003).

Where signs were located, a grid reference was recorded along with notes on the types of signs present and a photograph taken. Many of the otter signs were located within inaccessible boulder scree at the base of cliff faces at Lamba Ness. They were viewed with binoculars from safe locations from the top of the cliffs. Therefore, some of the grid references are indicative. Additionally, some of the clifftop edges were deemed to be too dangerous to survey during high winds that were ongoing during the survey period.

The otter surveys took place during suitably dry weather conditions, so that otter field signs (spraints, slides, sheltering or resting places etc.) would have had time to build up, be relatively visible and would not have been degraded/washed away e.g. after heavy rain.

Results

Numerous otter field signs were recorded during targeted surveys in March 2022 (Table 1). Three otter holts were recorded during surveys, though none were recorded within the design layout itself.

One building within the design layout was recorded as being used as a couch. Couches are daytime resting places for otters.

Several sprainting sites were recorded around the design layout during the survey, with the most active one recorded near an underpass below the main track across Lamba Ness which also had an otter runway through it.

O/S grid reference	Type of otter sign	Note
HP6743915639	Couch	Small building occasionally used by otters during survey. Footprints and spraint recorded.
HP6744115528	Spraint	Old spraint, area not recently used.
HP6751315453	Spraint	Fresh spraint.
HP6726915424	Holt	Holt site at foot of cliffs. Not visited directly due to access issues and high winds.
HP6725815487	Spraint	Fresh spraint.
HP6709015483	Runway	Clear runway through underpass.
HP6708915502	Spraint	Regularly and heavily used sprainting site.
HP6704815435	Holt	Holt site in boulder field at foot of cliffs.
HP6684315302	Holt	Holt site at base of cliff in scree slope.
HP6675915307	Spraint	Old spraint, not recently used.

Table 1: *Study Area otter signs March 2022*

Photo 1: *Footprints of an individual otter were recorded in a building within the development footprint at HP6743915639.*

Photo 2: *Fresh spraint was also recorded in the doorway of this building at HP6743915639.*

Photo 3: *Several of the old military buildings were partially if not fully submerged in water during the survey.*

Photo 4: *Underpass still showing signs of use, with trails leading through and sprainting site used recently (HP6709015483).*

	
Photo 5: *Sprainting site by lochan near underpass showing signs of recent use (HP6708915502).*	***Photo 6:*** *Sprainting site near entrance to main bunker at HP6744115528. This was not a recent spraint and no further evidence of use of the bunker was recorded.*
	
Photo 7: *Spraints and holts were recorded as in previous surveys outwith the design layout (often along the cliff edge and down scree areas).*	***Photo 8:*** *Additional areas within the design layout which could potentially be used as resting sites or couches were surveyed. None showed any evidence of regular use by otters.*

Discussion

The survey recorded evidence of use of parts of the design layout by otters. Following on from previous surveys, Lamba Ness remains important for otters. While some of the buildings were noted as being used by otters during the previous survey, only one had any evidence of recent activity during this pre-construction survey. This building was within the design layout (Figure 2) and in use as an otter couch/resting place.

The track underpass remains an important feature for otters, with a large and active sprainting site recorded near it. This appears to allow them to cross from one side of Lamba Ness to the other without having to swim around the headland. Also, the freshwater lochan on the north side of the underpass is considered likely to be an important place for otters to wash.

As a result, any changes to or demolition of the building being used as a couch at HP6743915639 will require a licence from NatureScot (as outlined in Alba Ecology, 2020b) before any works can commence on this building. Works across the remainder of the Study Area will be unaffected and do not require licensing. Finally, as the Lamba Ness peninsula is actively used by otters, the construction team and the Ecological Clerk of Works should be aware of, and keep a watching brief for their presence, especially when working in and around the old military buildings and at/around the underpass.

References

Alba Ecology (2020a) Shetland Space Centre Otter Survey Report 2018 and 2020.

Alba Ecology (2020b) Shetland Space Centre Otter Licensing Requirements.

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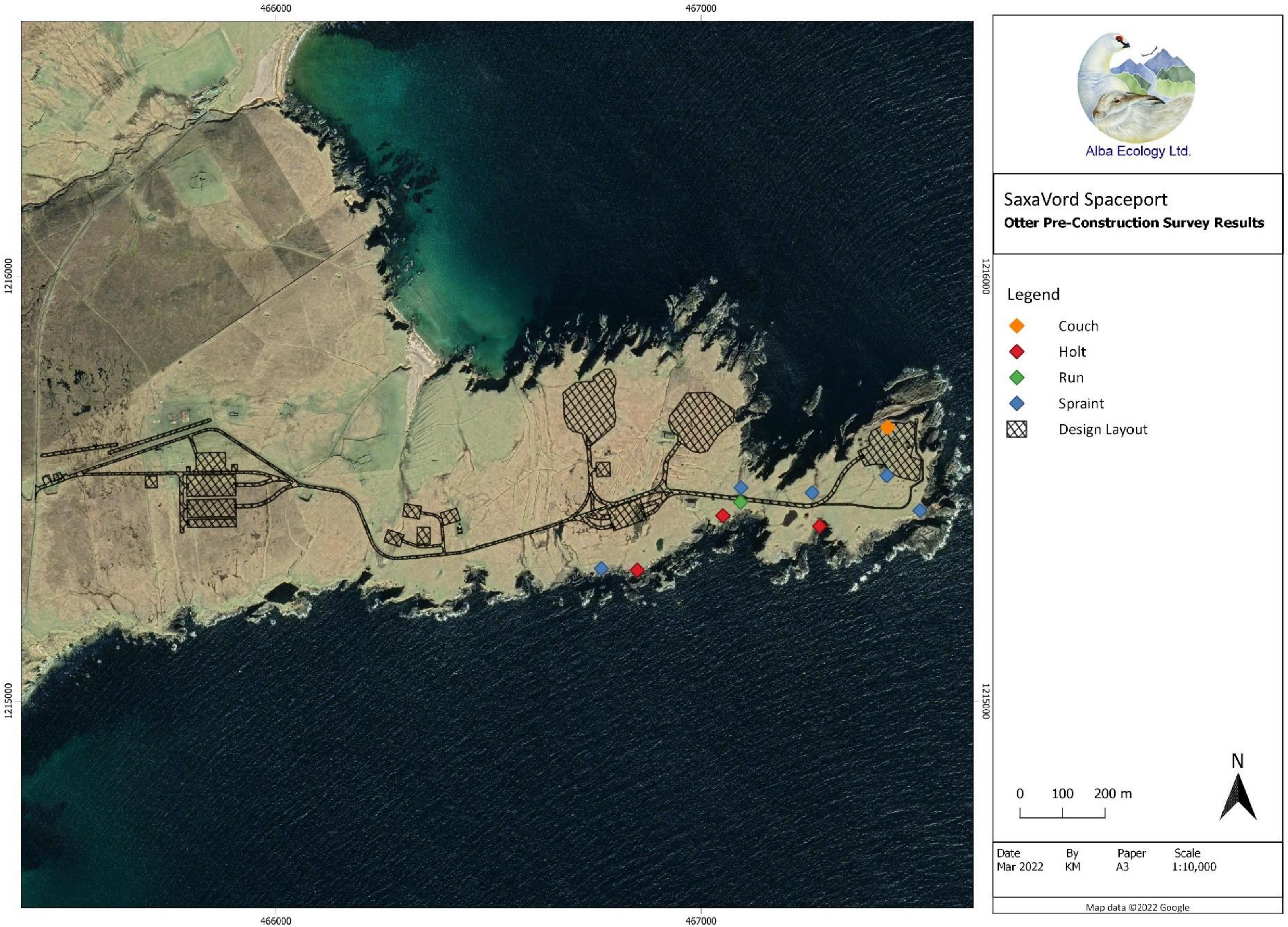

Figure 2: *Results of SaxaVord Spaceport Pre-construction Otter Survey*

Appendix 6.3c SaxaVord Otter Survey Report and Species Protection Plan 2024

Otter Survey Report for SaxaVord Spaceport, July 2024 Brydon Thomason

Introduction

In July 2025 I was approached by ITPEnergised to revisit the Otter survey of Lambaness Shetland Space Centre, knowing I had previously carried out the survey in 2018 and again in 2020.

Aim

To provide information to inform the proposed SaxaVord Spaceport development in Unst, Shetland an otter survey with three main stages was undertaken.

• Survey site selection;

• Otter surveys of potentially affected areas; and Otter Survey Report for SSC, and

• Otter survey report.

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended). According to NatureScot's standing guidance on otters (last accessed 14/08/24), there is no change to the protection of European Protected Species (EPS) as a result of EU Exit. It is an offence to deliberately or recklessly:

- kill, injure, capture or harass an otter;
- disturb an otter whilst it is occupying a holt (underground den) or other place it uses for shelter or protection, or while it is rearing or otherwise caring for its young, or in any way that impairs its ability to survive or breed, or significantly affects the local distribution or abundance of otters;
- obstruct access to an otter breeding site or resting place, or otherwise prevent their use.

And whether or not deliberate or reckless:

- to damage or destroy an otter breeding site or resting place.

This means that if otters could be affected in these ways by a development, and no action is taken to prevent it, an offence may be committed.

Licences for development works that would otherwise result in an offence with respect to EPS, such as otters, can only be issued by NatureScot. An up-to-date otter survey and an otter protection plan for a proposed development must be submitted with any licence application, together with details of the development proposals. It should be noted that there is a presumption against licensing disturbance to breeding otters and damage or destruction of an otter holt while being used for breeding. Licensed activity in this situation would have to wait until the otters had finished breeding and cubs are fully mobile (NatureScot, 2024).

According to the NatureScot's standing guidance "*surveys should be done by persons with the appropriate knowledge of otter ecology and practical experience of otter survey work*". The Study Area was surveyed under SNH licence for otters in 2018 and 2020 and 2024 by myself Mr Brydon Thomason, a highly experienced and locally based otter surveyor, with 20 years practical experience of working on otters, and over four decades of the species on Shetland.

Survey Site Selection

In this report and as informed, the survey concentrated on, and only within the Lamba Ness site and boundary (shown in red) as shown on Figure 1.

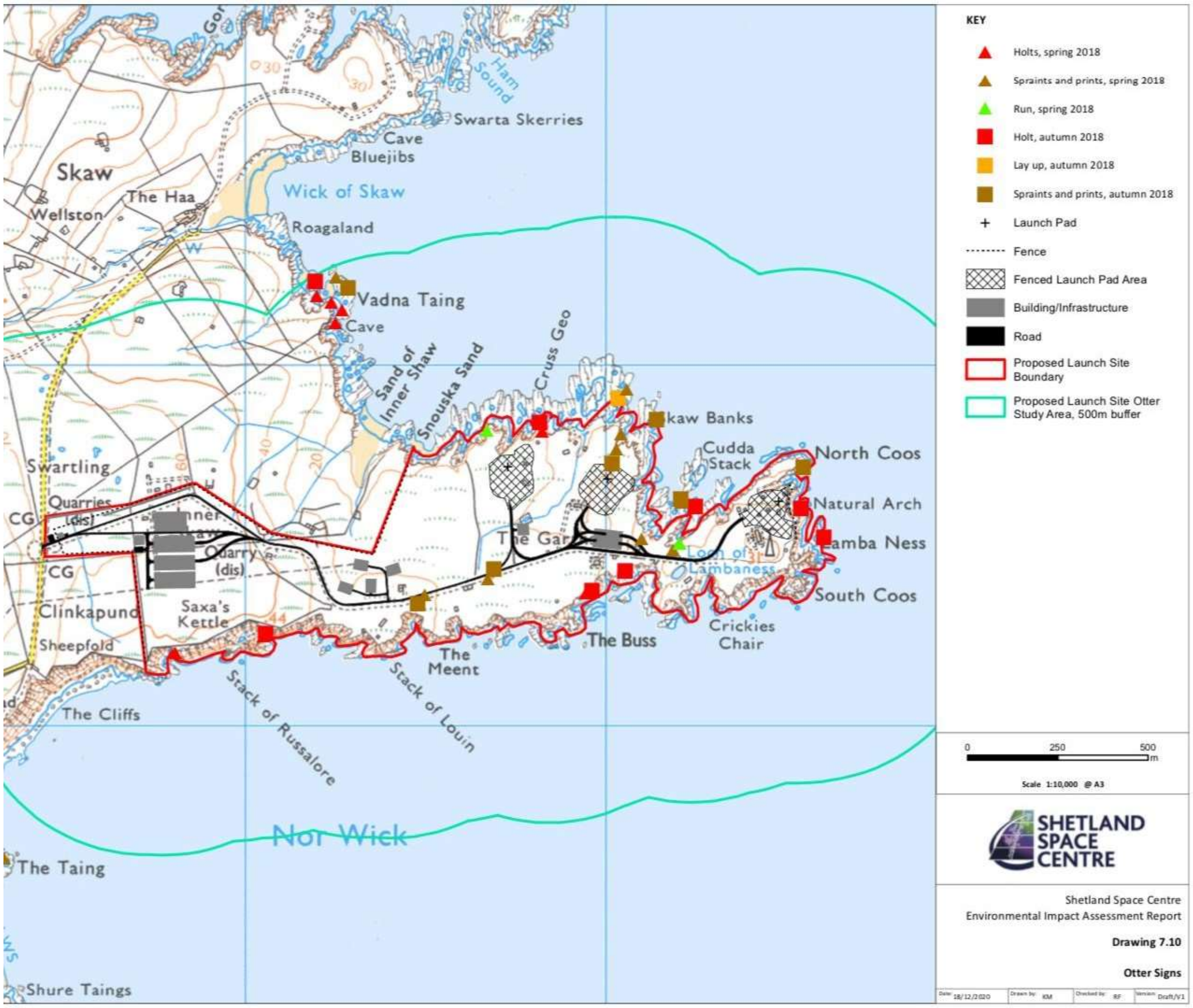

Figure 1: Study Area and Results from 2018 Otter Survey.

The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats within the Study Areas looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints) (Chanin, 2003).

Where otter signs were located an approximate grid reference was recorded along with notes on the type of signs and a photograph taken.

Many of the otter signs were located within inaccessible boulder scree at the base of cliff faces at Lamba Ness. They were viewed with binoculars from safe locations from the top of the cliffs. Therefore, some of the grid references locations are indicative.

The otter surveys took place during suitable weather conditions, so that otter field signs (spraints, slides, sheltering or resting places etc.) would have had time to build up, be relatively visible and would not have been degraded/washed away e.g. after heavy rain. Standard survey methods were followed, and any biases or limitations associated with these methods could potentially affect the results collected. Furthermore, while every effort was made to provide a full assessment and comprehensive description of otter use of the Study Area, surveys can achieve full characterisation due to variations that occur with time.

Results

Overall, the site remains similarly active as previous visits with pretty much all previous spraint points or potential hots, showing signs of usage over recent days/weeks (Figure 2, Table 1). As with previous surveys, all presumed holt sites were at base of cliffs, amongst large bolder scree clear of high-water mark. This usage of hots/lay-up/resting places are very typical to this type of coastline during the relatively calmer sea states of summer months.

None of the holts or presumed holts identified showed signs of usage that would suggest natal holt usage, however due to the seasonal preference for breeding, that could well change at any given time, particularly as we approach autumn.

The known otter run, which uses the underpass near the point of Lamba Ness, remains active and an important crossing point for otters. The increased site works traffic here does not appear to have deterred Otters from using this clearly important feature.

Historic bunkers on Lamba Ness are still being used by otters, presumably as resting places, though no bedding was found.

During the survey each of the ten artificial holts that were installed in May last year were inspected. None showed any signs of usage as yet.

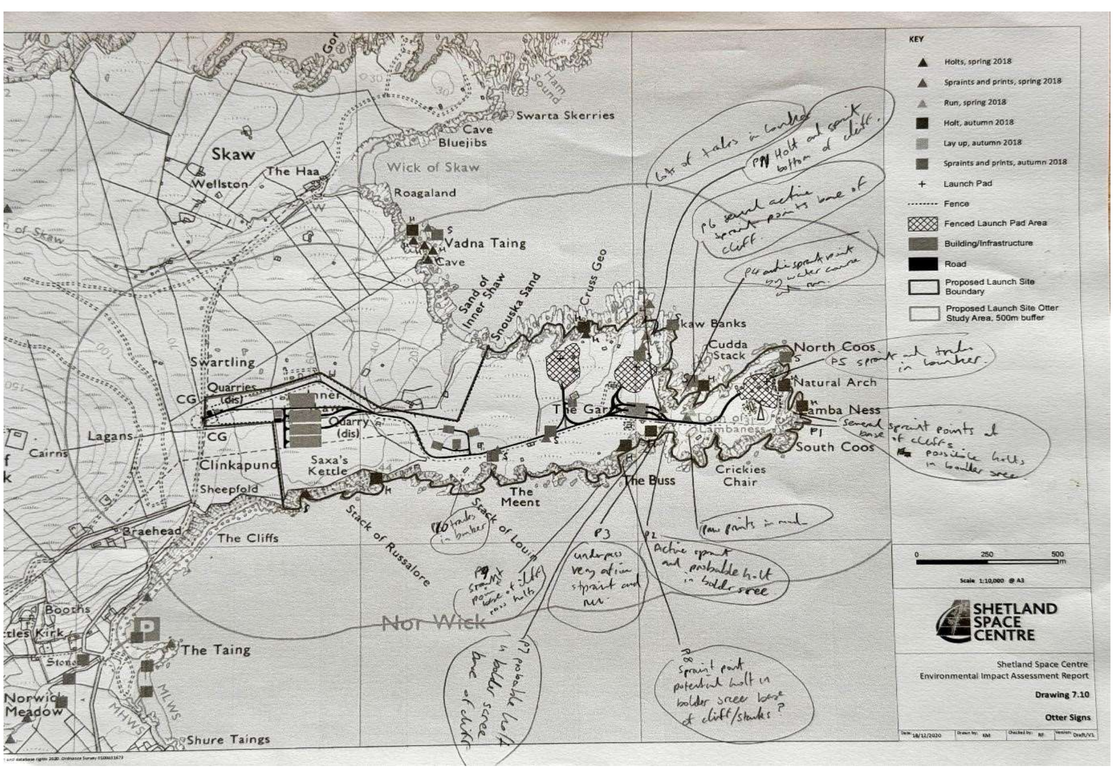

Figure 2: Survey field map scan, annotated with findings.

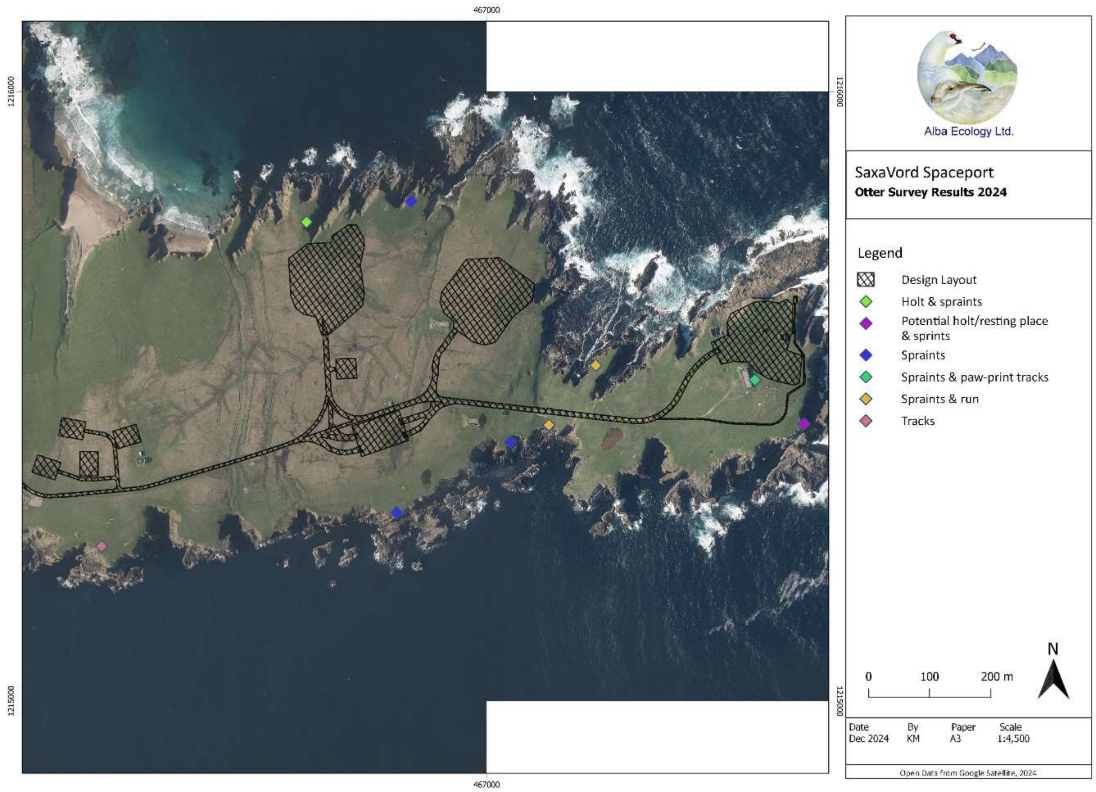

Figure 3: Digitised survey findings.

Table 1 gives all points of interest recorded and presented in tabular format.

Position No and OS	Activity noted	Comments
P1 HP67521 15455	Spraint and potential holt/resting place	Several spraint points at base of inaccessible cliff, with potential holts/resting places
P2 & 3 HP67102 15453	Spraint point & run	Active spraint point underneath, and run to and from, underpass
P4 HP67179 15551	Spraint point & run	Spraint point at base cliff at end of run, < >underpass.
P5 HP67440 15527	Spraint point & paw-print tracks	Spraint point and many paw print-tracks inside bunker
P6 HP67039 15425	Spraint Point	Very active spraint points (several) at base of accessible cliff. Most active point on entire survey site.
P7 HP66852 15309	Spraint Point	Active spraint points at base of cliff, most of area unviewable from clifftop.

P8 HP66876 15820	Spraint Point	Active spraint points at base of cliff, most of area unviewable from clifftop.
P9 HP66368 15254;	Tracks	Paw-print tracks inside bunker.
P10 HP66704 15786	Spraint point & holts	Active holt in bolder scree, and on cliff bellow position photographed from

Table 1: Otter Survey results

Images of points of interest recorded, as listed in table above.

P1 HP67521 15455: several spraint points at base of cliff, with potential holts/resting places.

P2 & 3 Underpass HP67102 15453: spraint point underneath, and run to and from, underpass.

P4 HP67179 15551: spraint point at base cliff at end of run, < >underpass.

P5 HP67440 15527: spraint point and many paw print-tracks inside bunker.


P6 HP67039 15425: very active spraint points (several) at base of accessible cliff. Most active point on entire survey site.

P7 HP66852 15309: active spraint points at base of cliff, most of area unviewable from clifftop.

P8 HP66876 15820: active spraint points at base of cliff.

P9 HP66368 15254: paw-print tracks inside bunker.

P10 HP66704 15786: Active holt in bolder scree, and on cliff bellow position photographed from.

Conclusion

The site overall remains occupied by Otters to a similar level of activity, though slightly fewer holts suspected. Though most identified or presumed holt sites remain inaccessible, with binoculars and high level of experience it was easy to identify signs of activity.

It is interesting to note that the level of occupancy remains similar to pre-construction/works commencing.

Brydon Thomason

14th July 2024

SaxaVord Spaceport Otter Protection Plan

Alba Ecology Ltd.

2024 update

This report should be quoted as '*Alba Ecology Ltd. (2024 update). SaxaVord Spaceport Otter Protection Plan*'.

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INTRODUCTION

Otters are known to be present within the SaxaVord Spaceport Application Boundary area, which was surveyed in detail for otters between 2018 and 2020 ahead of the planning submission. Planning Condition 17 of the SaxaVord Spaceport planning consent states:

No development shall commence unless and until:

(a) i) a pre-construction otter survey is conducted and a report produced; ii) based on the results from the pre-construction otter survey apply for an otter licence, if necessary, from NatureScot; and iii) until such otter licence (if necessary) is issued, not carry out any works on any otter holts.; and

(b) an Otter Protection Plan (OPP) has been submitted to and approved in writing by the Planning Authority following consultation with NatureScot, which shall provide for a programme of future monitoring for otters on the site to allow the adaptation of management under the approved OPP as may be agreed to in writing by the Planning Authority.

The approved OPP shall be complied with during the carrying out and operation of the development hereby permitted.

A pre-construction otter survey was undertaken in 2022 and another survey carried out in 2024 following construction of Launch Pad 1 (LP1) and the first hotfire test event. The OPP has been already produced (as a ‘live’ document and is updated and amended on several occasions as when necessary) and the focus of this 2024 update has now shifted on to the operational phase of the development, although noting that additional construction elements (finishing construction of LP2 and LP3) are still likely to take place.

Legal protection

Otters are classed as European Protected Species (EPS) under the Conservation (Natural Habitats, &c.) Regulations 1994 (as amended).

According to NatureScot’s standing guidance on otters, it is an offence to deliberately or recklessly:

- capture, injure or kill an otter;
- harass an otter or group of otters;
- disturb an otter in a holt or any other structure or place it uses for shelter or protection;
- disturb an otter while it is rearing or otherwise caring for its young;
- obstruct access to a holt or other structure or place otters use for shelter or protection, or otherwise deny the animal use of that place;
- disturb an otter in a manner or in circumstances likely to significantly affect the local distribution or abundance of the species; and
- disturb an otter in a manner or in circumstances likely to impair its ability to survive, breed or reproduce, or rear or otherwise care for its young.

It is also an offence to:

- damage or destroy a breeding site or resting place of such an animal (whether or not deliberately or recklessly); and
- keep, transport, sell or exchange, or offer for sale or exchange any wild otter (or any part or derivative of one) obtained after 10 June 1994.

Otter shelters (holts and couches) are legally protected whether or not an otter is present. This means that if otter shelters could be affected by a development, and no action is taken to prevent it, an offence may be committed. According to NatureScot "*Licensing allows named individuals to carry out actions that could otherwise constitute an offence. If you're planning any activities that could affect otters or the places they use, you must make sure you stay within the law*".

SURVEY RESULTS

For ease of reference, the following is a summary of targeted otter survey results undertaken between 2018-2024 at Lamba Ness, Unst, Shetland.

2018 – Otter Survey

Numerous otter field signs were recorded during targeted otter surveys in June 2018 (Table 1; Figure 1) and October 2018 (Table 2; Figure 1).

Table 1. Otter signs, June 2018.

O/S grid reference	Type of sign	Note
HP6580215203	Holt	Obvious holt site with spraint at foot of cliff amongst boulder scree.
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff.
HP6649615366	Spraint/print	Small amount spraint but many fresh paw prints inside old concrete bunker.
HP6667215410	Spraint	Spraint site with drying green by concrete found of old bunker and run leading to flash pool.
HP6694415371	Holt	Active holts in boulder scree at foot of cliffs.
HP6705015430	Holt	Recently active holt at top of cliff in boulder scree.
HP6709915521	Spraint	Spraint site at old bunker.
HP6718515489	Spraint	Active spraint site at bottom of cliff on boulder scree.
HP6720315508	Spraint/run	Run leading from spraint point at foot of cliff across headland through underpass to the other side.
HP6762115529	Holt	Active boulder scree holt at foot day of cliff.
HP6720815622	Spraint	Freshwater bathing pool active spraint site run from one side of headland to other.
HP6707815936	Spraint	Active spraint site.
HP6704215811	Spraint	Stream side spraint site, inactive.
HP6702915769	Spraint	Stream side spraint site.
HP6701415731	Spraint	Stream side spraint point active.
HP6682215819	Holt	Active holt at foot of cliff boulder scree.
HP6666915820	Run	Run up and down cliff from small geo leading up to small ditch.
HP6630416163	Holt	Active boulder scree holt at foot of cliff.
HP6634616188	Holt	Run across small headland provable holt below cliff top.
HP6628316222	Holt, inactive	Clifftop holt, not recently active.
HP6626616261	Holt, inactive	Clifftop holt, not recently active.
HP6624416270	Spraint	Stream side spraint site.

HP6475316325	Spraint	Stream side spraint point, just outside buffer zone.
HP6451216235	Spraint	Stream side spraint site.
HP6471814142	Spraint	Spraint point, bridge.
HP6477814289	Spraint	Stream side spraint site.
HP6483414368	Spraint	Stream side spraint site.
HP6495114419	Spraint	Stream-side spraint point.
HP6538914686	Spraint	Inactive spraint site.
HP6524614816	Spraint	Inactive spraint site.

Table 2. Otter signs, October 2018.

O/S grid reference	Type of sign	Note
HP6604915254	Holt	Obvious holt amongst boulder scree at foot of high cliff.
HP6647715340	Spraint/print	Currently inactive - spraint/paw prints in old bunker.
HP6668815436	Spraint	Active spraint site.
HP6696015377	Holt	Active holt in boulder scree bottom of cliffs.
HP6705115430	Holt	Relatively active holt at top of cliff.
HP6762115529	Holt	Active boulder scree holt at foot day of cliff.
HP6754015606	Holt	Bunker used as holt very active.
HP6754715719	Spraint	Active bunker spraint site.
HP6724715610	Holt/lay-up	Boulder scree holt/lay-up.
HP6720615630	Spraint	Active spraint site by stream and run across headland.
HP6713915851	Spraint	Spraint at clifftop.
HP6708915930	Spraint/lay-up	Active spraint site, lay-up.
HP6701615730	Spraint	Active stream spraint site.
HP6681515845	Holt	Active hots in boulder scree foot of cliffs.
HP6628416216	Print	Paw prints aside fresh dug holts but no spraint point (previously active) along clifftop.
HP6623916259	Holt/spraint	Active spraint site by stream, relatively active holt on clifftop.
HP6534214469	Tracks/spraint	Tracks and spraint on sand and at stream.
HP6526314527	Spraint/print	Spraint site and paw prints along stream and beach.
HP6521114661	Spraint	Very active spraint site by underpass - cub spraint noted confirming mother with family.
HP6502514580	Spraint/print	Spraint and paw prints in mud by stream.
HP6497714508	Spraint/print	Paw prints and spraint along stream- mum and cub sets together.
HP6495214421	Spraint/print	Spraint and paw prints along stream- again cub prints with adult
HP6472914171	Spraint	Spraint site at underpass.
HP6352014285	Spraint	Fresh spraint at roadside underpass.
HP6385913627	Spraint	Fresh spraint site at underpass.
HP6391513674	Spraint	Spraint site at underpass.

2020 – Otter Survey

In July 2020, targeted otter surveys were undertaken, and once again numerous otter field signs were recorded (Table 3; Figure 1).

Table 3. Otter signs, July 2020.

O/S grid reference	Type of sign	Note
HP 66032 15254	Holt	Inaccessible holt within boulders of cliff face.
HP 66033 15255	Holt	Inaccessible holt within boulders of cliff face.
HP 66367 15253	Prints	Fresh footprints located within the small, abandoned building.
HP 66764 15296	Holt	This holt was inactive in July 2020.
HP 66832 15296	Holt	This holt may have been active in July 2020. There were old and more recent spraints visible.
HP 66854 15291	Lay-up	The lay-up was in the boulder scree at this location.
HP 67046 15425	Holt	There was a holt at this location, within the boulder scree.
HP 67091 15465	Run	The underpass showed signs of frequent use by otters. There was a clear run from the rocks to the underpass.
HP 67510 15446	Lay-up and run	A commonly used lay-up and run within the rocks of the edge of cliff.

HP 67530 15451	Holt	Potential holt site. Appears inactive this season.
HP 67431 15532	Spraint/print	This abandoned building had many signs of otter use including spraints and footprints. It is likely used as a couch.
HP 67439 15637	Prints	There were otter footprints in this abandoned building. The prints were of two different sizes, indicating a female and young.
HP 67136 15532	Holt	This was the most active holt in 2020. There was a large pile of spraints which included crab remains. Crabs are easy kills for young otters. This holt was likely to have a female with young.
HP 66740 15785	Holt	Potential holt. Spraints recorded here.

Based on these surveys, there was evidence that the Proposed Development site was regularly used by otters. The EIAR recognised that otters could be directly affected by the construction and operation of the SaxaVord Spaceport (i.e. the planned work could potentially kill, injure, capture or disturb an otter whilst it is occupying a holt or other places of rest/shelter) and so an OPP was considered necessary and as a consequence Planning Condition 17 stipulated this as a legal requirement.

Figure 1 illustrates the known legally protected otter features across the Lamba Ness based on 2018-2020 data, prior to construction commencing.

2022 - Pre-construction Otter Survey

As a pre-construction survey, this was conducted just prior to the planned commencement of construction works on the project. The survey methods involved a systematic survey of terrestrial, aquatic and riparian habitats at Lamba Ness looking for places otters use for shelter, resting and protection (such as couches, lying-up sites and holts), or for signs of activity (such as spraints, feeding remains, runs or footprints) as per best practice (Chanin, 2003). Numerous otter field signs were recorded during targeted surveys in March 2022 (Table 4). Three otter holts were recorded during surveys (Figure 2), though none were recorded within the SaxaVord Spaceport layout itself.

Table 4. Otter signs, March 2022.

O/S grid reference	Type of sign	Note
HP6743915639	Couch	Small building occasionally used by otters during survey. Footprints and spraint recorded.
HP6744115528	Spraint	Old spraint, area not recently used.
HP6751315453	Spraint	Fresh spraint.
HP6726915424	Holt	Holt site at foot of cliffs. Not visited directly due to access issues.
HP6725815487	Spraint	Fresh spraint.
HP6709015483	Runway	Clear runway through underpass.
HP6708915502	Spraint	Regularly and heavily used sprainting site.
HP6704815435	Holt	Holt site in boulder field at foot of cliffs.
HP6684315302	Holt	Holt site at base of cliff in scree slope.
HP6675915307	Spraint	Old spraint, not recently used.

2023 – Otter Holt Installation

In May 2023, ten artificial otter holts were built and installed across Lamba Ness (Figure 3).

Figure 1. Otter signs 2018-2020.

Figure 2. Otter signs, with 30m buffer marked around otter holts (March 2022).

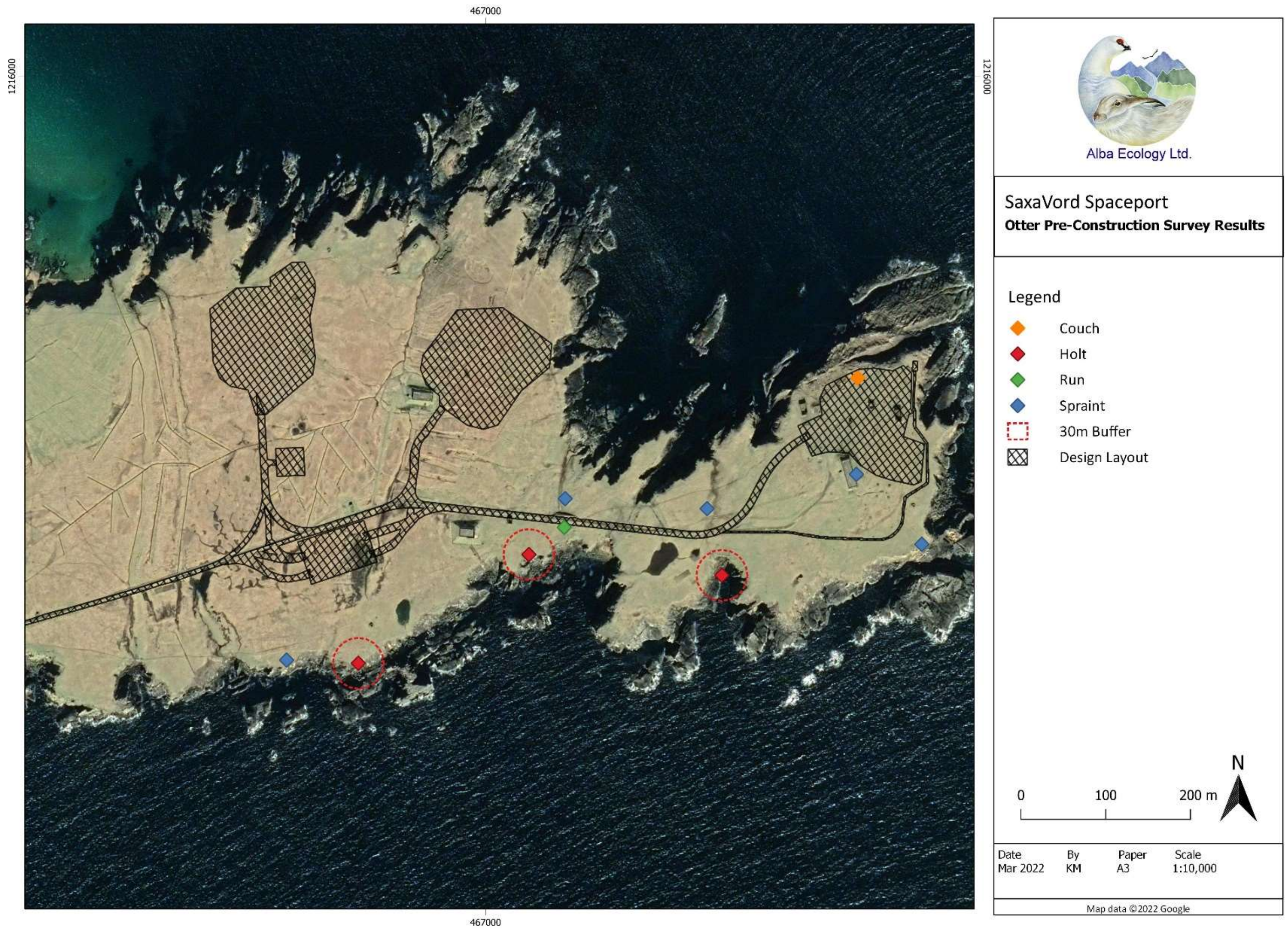
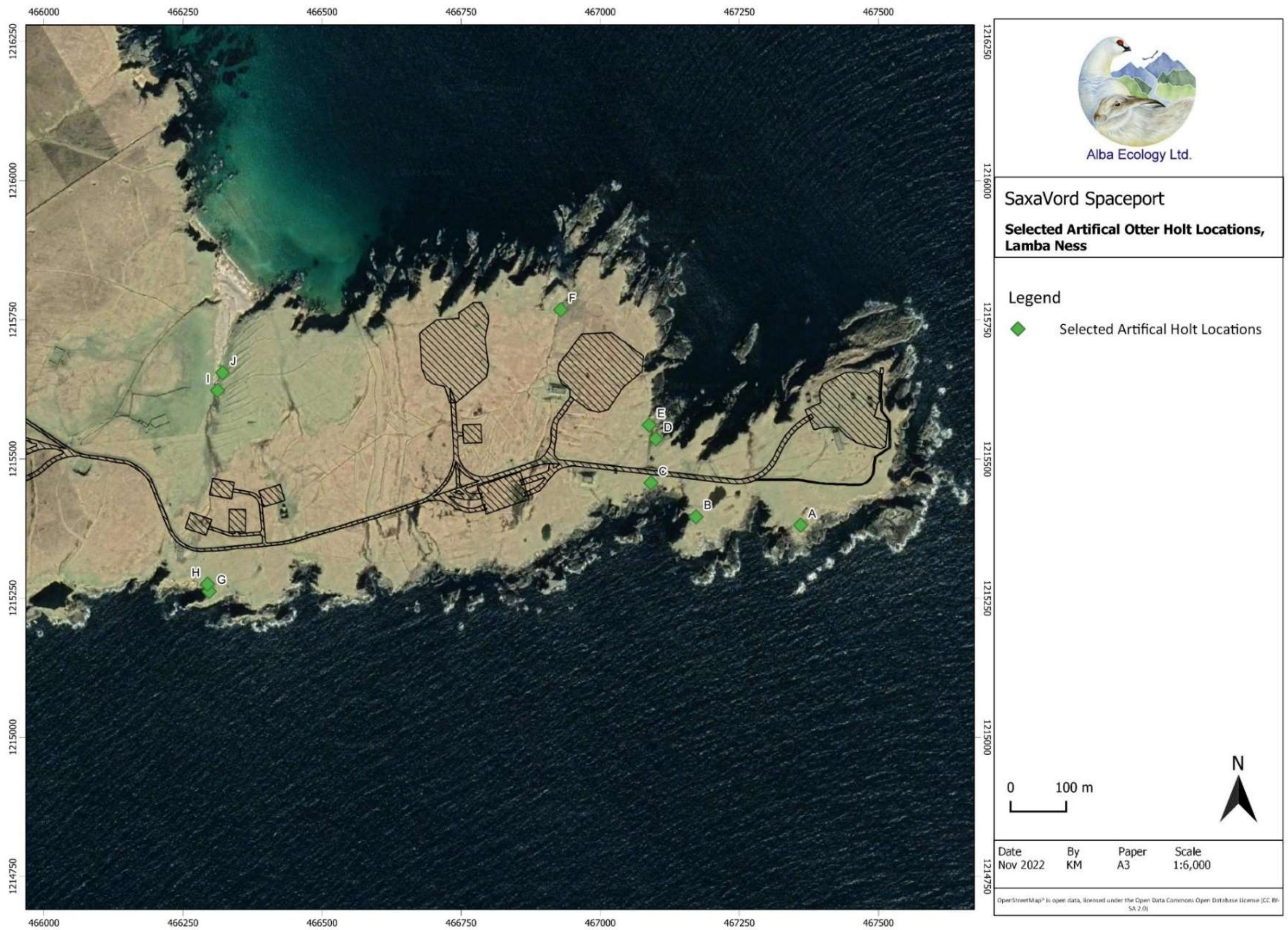


Figure 3. Artificial otter holts built and installed in 2023.



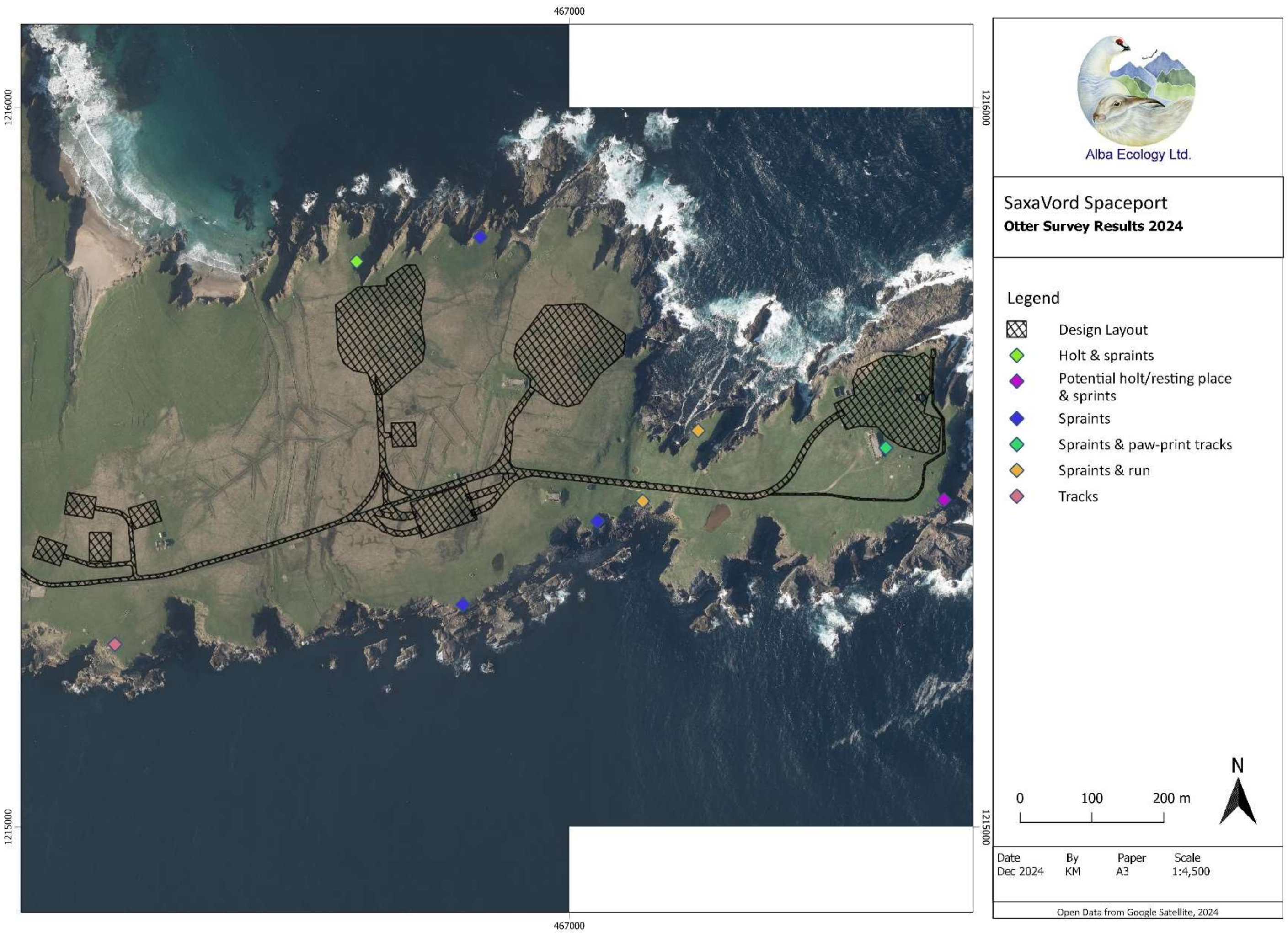
2024 – Otter Survey

In August 2024, an otter survey was undertaken after most construction work had been completed (Brydon Tomason, 2024). Overall, Lamba Ness remained similarly active as previous years with most previous spraint points or potential holts showing recent signs of usage (Table 5). As with previous surveys, all presumed natural holt sites were at base of inaccessible cliffs, amongst large bolder scree clear of high-water mark. This usage of holts/lay-up/resting places are typical to this type of coastline during the relatively calmer sea states of summer months. None of the natural holts or presumed holts showed signs that would suggest natal holt usage, however due to the seasonal preference for breeding, that could change. The ten artificial holts installed in 2023 (Figure 3) were investigated in August 2024, and none showed any signs of otter usage/occupancy.

Table 5. Otter signs, August 2024.

O/S grid reference	Type of otter sign	Note
P1 HP 67521 15455.	Spraint and potential holt/resting place.	Several spraint points at base of inaccessible cliff, with potential holts/resting places.
P2 & P3 HP 67102 15453.	Spraint point & run.	Active spraint point underneath, and run to and from, underpass
P4 HP 67179 15551.	Spraint point & run.	Spraint point at base cliff at end of run, < >underpass.
P5 HP67440 15527.	Spraint point & paw-print tracks.	Spraint point and many paw print-tracks inside bunker.
P6 HP 67039 15425.	Spraint Point.	Very active spraint points (several) at base of accessible cliff. Most active point on entire survey site.
P7 HP 66852 15309.	Spraint Point.	Active spraint points at base of cliff, most of area unviewable from clifftop.
P8 HP 66876 15820.	Spraint Point.	Active spraint points at base of cliff, most of area unviewable from clifftop.
P9 HP 66368 15254.	Tracks.	Paw-print tracks inside bunker.
P10 HP 66704 15786	Spraint point & holts.	Active holt in bolder scree at base of cliff.

Figure 4. Otter signs 2024.



MINIMISING IMPACTS

There is a good understanding of how otters at Lamba Ness use the habitats present with many holts at the base of sea cliffs and used during suitable weather. During inclement weather (e.g. winter storms), some of these holts would potentially be inundated with sea water. At such times, the otters probably made regular use of the old abandoned open military buildings which became *de faco* holts/resting places.

The track underpass is also an important feature for otters, allowing them to cross from one side of Lamba Ness to the other without having to swim around the point or cross a large area of open ground and an access track. Based on monitoring with static cameras by the ECoW during construction works, this feature appears to be important functionally (both day and night), particularly during inclement weather.

The measures within this OPP follow the well-established hierarchy of avoidance, mitigation and compensation as outlined in the actions in Table 6. It is important to recognise that otter use of the Site may vary over time and planned actions will need to account for this (i.e. be responsive). Consequently, the OPP actions (Table 6) should be regularly reviewed to ensure they are fit for purpose and this document should remain 'live' and be updated by the ECoW/ecologist as and when necessary.

Table 6. Otter Protection Plan Actions.

Action	Location	Comments
Tool-box talk and site materials.	Site Office	All construction/operational workers and site staff will be given a tool-box talk which covers OPP issues. Sensitive and legally protected otter features have been marked-up on relevant construction and operational plans and will be updated in light of new survey information.
Create otter sensitive zones.	Natural holts, artificial holts, couches and underpass	Sensitive areas will be physically marked on the ground using coloured pegs and sometimes with a rope/line marker chalk paint. It should be recognised that standard canes and marker tape typically used to mark-up sensitive areas get damaged and blown away by the strong winds. Therefore, strong, low markers, fixed securely into the ground or marked directly onto the ground with line marker chalk paint have been found to be the most resilient to adverse weather conditions on Unst.
Up to date otter surveys	Site wide	Pre-construction surveys for signs of otters were undertaken in 2022 prior to works commencing on the SaxaVord Spaceport and pre-operational surveys were undertaken in 2024 prior to SaxaVord Spaceport becoming fully operational. Site-wide otter surveys are planned biannually, with launch specific monitoring on artificial holts (see Otter Operational Monitoring Plan) around every launch cycle.
All operational work must avoid damage and/or destruction of otter holts/couches unless under licence from NatureScot.	Site wide	Operational plans avoid damage and/or destruction of natural otter holts, which lie at the base of inaccessible sea cliffs and so will be unaffected. Ten artificial holts/shelters have been built and installed across Lamba Ness (Figure 3). Trail cameras are used regularly and will be used to identify if any new and potentially important otter shelters are being used.

Retention of the established and well used run, underpass and freshwater pool.	HP 671 154	The underpass has been extended and an additional tunnel added to facilitate crossings if the existing tunnel is inundated during wet weather. The adjacent well-used run and freshwater pool will be retained to maintain important connectivity between the north and south sides of Lamba Ness. During operation, regular site walkovers will be undertaken by staff and one routine task built into forward work plans will be to check that the underpass is not blocked with debris.
Working in vicinity of otter holts/couches in the hours darkness.	Site wide	Unlike on the mainland, otters using coastal habitats on Unst are diurnal and so not limited to nocturnal or crepuscular hunting/feeding.
Avoid disturbance to existing otter holts/couches.	Site wide	Mark work exclusion zones around any holts and shelters. If otters are breeding, the disturbance-free zone should be at least 200m. However, it could be reduced to 100m depending on the nature of the works, topography and natural screening. This will require judgement from an experienced ecologist. For holts and shelters where otters are not breeding, the exclusion zone should be 30m. Where exclusion zones of the required size are not possible, works will require a licence from NatureScot before they can proceed. Regular monitoring will inform such deliberations (see Otter Operational Monitoring Plan). 30m exclusion zones will be maintained around the two active holt locations identified in August 2024. The active holts were located within inaccessible boulder scree at the base of inaccessible sea cliffs; neither of which were considered likely to be active natal holts. As the Lamba Ness peninsula is actively used by otters, the construction and operational team and the ECoW are aware of, and keep a watching brief for, their presence.
Cap exposed pipes when not in use.	Site wide	All exposed pipes and tunnel openings must be capped or shut when not in use to prevent otters from entering them and potentially getting trapped/injured/killed.
Enforce safe-working vehicle speed limit.	Site wide	Vehicle speed limit of 10 mph enforced across the Site to reduce possibility of otter traffic mortality/injury from both construction and operational vehicle use.
Awareness raising for drivers.	Entrance and main track	Otter crossing road signs will be located at the Site entrance and at other strategic locations along the main track, specifically including both sides of the access track ‘bridge’ with the otter underpass.
Installation of ten artificial holts to replace any natural holts/couches that have to be destroyed or damaged.	Site wide	None of the natural holt sites will be lost due to operational activities as they are all recorded in inaccessible locations in the boulder scree and caves at the foot of cliffs which have deliberately avoided. To mitigate for the loss of potentially occasionally used shelters during construction a series of ten artificial otter holts have been installed across Lamba Ness (Figure 3).
Provide shelter and protection from potential disturbance during launches.	Site wide	A series of ten artificial holts have been built and installed across Lamba Ness to provide shelter for any otters using the SaxaVord Spaceport. One aim of these holts will be to provide shelters for any otters that are away from their natural holt at the base of cliffs during launches. The use of these ten artificial holts will be systematically monitored through the use of static motion-triggered cameras - see Operational Otter Monitoring Plan for further details.

Licensing development works affecting otters

Licences for development works that would otherwise result in an offence with respect to EPS such as otters, can only be issued if it can be demonstrated that the following three tests are all met:

- Test 1 - that the purpose of the licence is to preserve public health or public safety or for other imperative reasons of overriding public interest, including those of a social or economic nature and beneficial consequences of primary importance for the environment.
- Test 2 - that there is no satisfactory alternative.
- Test 3 – that the proposed action will not be detrimental to the maintenance of the population of the species at a favourable conservation status in their natural range.

There is a presumption against licensing disturbance to breeding otters and damage or destruction of an otter holt while being used for breeding. Nevertheless, according to the NatureScot standing advice “*developers can apply for a licence to allow proposed development works that might affect otters to proceed legally*”. Given the loud noise during launches, a NatureScot licence to disturb otters for a period of 5 years has been applied for by the Applicant.

REFERENCES

Chanin P. (2003) Monitoring the otter *Lutra lutra*. Conserving Natura 2000 Rivers Monitoring Series No.10. English Nature, Peterborough.

NatureScot (no date) Standing Advice for Planning Consultants. Protected Species: Otter. Otters: licences for development | NatureScot [accessed October 2024].

Appendix 6.4 SaxaVord Spaceport Freshwater Pearl Mussel Survey Report

Shetland Space Centre Freshwater Pearl Mussel Survey

Alba Ecology Ltd.

April 2020

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Summary

Background

Scotland is a global stronghold for the freshwater pearl mussel (*Margaritifera margaritifera*), a species now fully protected under the Wildlife and Countryside Act (1981) (as amended) of Great Britain. It is also listed on Annexes II and V of the EC Habitats Directive (Council Directive 92/43/EEC) and Appendix III of the Bern Convention. Estimates suggest that Scotland holds a large proportion of the world's remaining viable populations, with several sites of national and international importance in the north of Scotland, including Shetland.

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a freshwater pearl mussel survey in a watercourse immediately adjacent and downslope to the proposed planning application boundary on Unst. The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road at Northdale, (ii) a proposed Launch and Range Control Centre Site, and (iii) a proposed Launch Site. The first of these areas had running water (the Burn of Norwick) downslope and so was considered further in relation to potential freshwater pearl mussel sensitivities.

Main Findings

- The Burn of Norwick was surveyed by Dr Peter Cosgrove, an experienced and licensed freshwater pearl mussel surveyor in September 2018.
- No evidence of freshwater pearl mussels was found in the Burn of Norwick survey reach.
- No patches of suitable or potentially suitable substrate habitat were recorded in the Burn of Norwick survey reach.
- This report provides survey evidence that no freshwater pearl mussels were present within the Burn of Norwick survey reach. Consequently, the survey evidence suggests that there are no special freshwater pearl mussel sensitivities that need to be considered. Nevertheless, freshwater pearl mussels are highly sensitive to changes in water quality, and if present and undetected (and there is no evidence for this) it will be important to avoid any sources of pollution or runoff from the site during proposed works by following best practice measures when working around watercourses.

Introduction

Aim

To provide information to inform the proposed Shetland Space Centre (SSC) development in Unst, Shetland a freshwater pearl mussel (*Margaritifera margaritifera*) survey with three main stages was considered necessary.

- Watercourse survey site selection;
- Freshwater pearl mussel survey of all potentially affected watercourses; and
- Report and recommendations.

Species background

During the past 100 years, the freshwater pearl mussel has declined throughout its Holarctic range to such an extent that it is now listed as an endangered species (IUCN, 1991). Scotland is a global stronghold for the freshwater pearl mussel, a species which is now fully protected under the Wildlife and Countryside Act (1981) (as amended) of Great Britain. It is also listed on the Annexes II and V of the EC Habitats Directive (Council Directive 92/43/EEC) and Appendix III of the Bern Convention.

Recent estimates suggest that Scotland holds an important proportion of the world's known remaining viable populations (e.g. Cosgrove *et al.* 2000a; Cosgrove *et al.* 2016). However, the species has declined in Scotland, with gross industrial and agricultural pollution, over-exploitation by pearl fishers, decline in salmonid host stocks (the short parasitic larval stage of freshwater pearl mussels is entirely dependent upon salmon and trout fry) and physical river bed habitat degradation due to hydro-electric operations and small-scale river engineering works (Cosgrove *et al.* 2000a; Cosgrove *et al.* 2016).

Every year, new undiscovered pearl mussel populations are found in Scotland during targeted surveys. Freshwater pearl mussels were rediscovered in Shetland in 2002 (Cosgrove and Harvey, 2003; Cosgrove and Harvey, 2005) and so surveys of watercourses holding potentially suitable freshwater pearl mussel habitats in Shetland are required to account for this legally protected species within the SSC Study Area.

Habitat requirements

Freshwater pearl mussels are found in fast flowing rivers and streams, with detailed studies on Scottish freshwater pearl mussel populations suggesting that optimum water depths of 0.3 - 0.4m and optimum current velocities of 0.25 - 0.75ms-1 at intermediate water levels are most suitable (Hastie *et al.* 2000). River bed substratum characteristics appear to be the best physical parameters for describing freshwater pearl mussel habitat. Freshwater pearl mussels prefer stable cobble/boulder dominated substrate with some fine substrate that allows the mussels to burrow (Cosgrove *et al.* 2000b). Adult and juvenile mussels tend to have similar habitat 'preferences', although adults are found over a wider range of physical conditions and juveniles appear to be more exacting in their requirements and sensitivity to environmental disturbance (Hastie *et al.* 2000). Juvenile mussels prefer finer stable sediments than adults, particularly clean sand and gravel.

Freshwater pearl mussels live buried or partly buried in the beds of clean, fast-flowing unpolluted streams and rivers and subsist by inhaling and filtering for the minute organic particles on which they feed (Cosgrove *et al*. 2000b). Of specific importance to freshwater pearl mussel survival are detrimental levels of silt, algae, suspended solids, calcium and chemical compounds generally associated with enrichment (eutrophication) i.e. nitrate, phosphate and biological oxygen demand (Bauer 1983). Various types of river engineering work can detrimentally impact the habitat of freshwater pearl mussels (Cosgrove and Hastie, 2001).

Freshwater pearl mussels have a short parasitic larval phase on the gills of suitable host fish. The larvae (glochidia) are very host-specific and can only complete their development on Atlantic salmon *Salmo salar* or brown trout *Salmo trutta*. Usually juvenile fish (fry and parr) are utilised (Young and Williams 1984). The presence of freshwater pearl mussels in any river therefore depends on salmonid host fish availability. It is usually considered necessary for migratory salmonids to be present within a catchment for freshwater pearl mussels to be present.

Methods

Survey site selection

A proposal for a space centre has been made by the Applicant in north Unst, Shetland. As part of this proposal, Alba Ecology Ltd. was commissioned to conduct a freshwater pearl mussel survey in watercourse immediately adjacent to the proposed planning application boundary on Unst. The proposal comprises of work in three discrete areas: (i) a proposed New Section of Access Road at Northdale, (ii) a proposed Launch and Range Control Centre Site, and (iii) a proposed Launch Site. The first of these areas had running water (the Burn of Norwick) downslope and so was considered further in relation to potential freshwater pearl mussel sensitivities.

On the basis that there are no known historical records of freshwater pearl mussels within the Planning Application boundary, survey site selection was directed towards establishing the status (presence or absence) of freshwater pearl mussels and habitat suitability within potentially suitable watercourses in (or immediately adjacent to) the proposed planning application boundary.

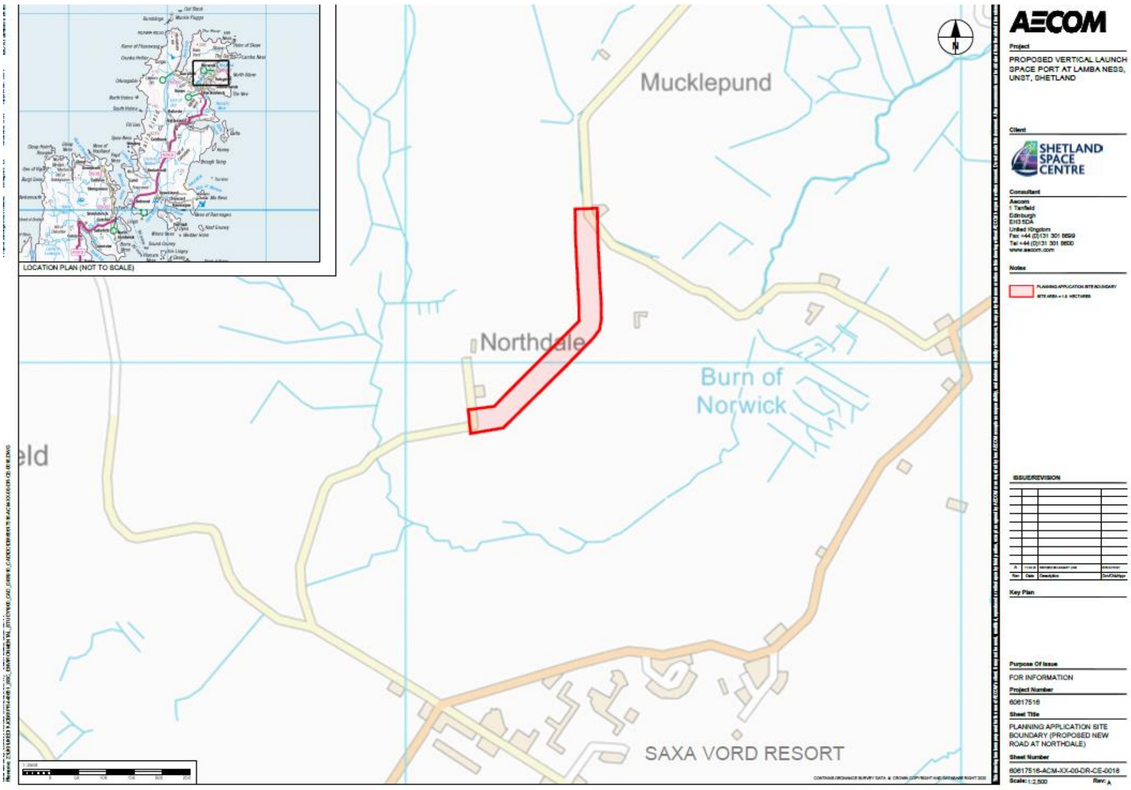

Figure 1. Proposed New Section of Access Road Boundary (red line) and the Burn of Norwick.

Survey site selection was based around knowledge of the species' habitat, host fish requirements, the Study Area and standard SNH guidance for shallow-water freshwater pearl mussel surveys (SNH, 2008). Whilst the proposed New Section of Access Road does not cross the Burn of Norwick, access from the west to and from this new road does and so it was considered important to establish presence or absence of freshwater pearl mussels (as well as habitat suitability) around this existing bridge crossing.

Survey methodology

The watercourse was entered and searched for freshwater pearl mussels, where Health and Safety conditions allowed, using an adapted version of the standardised shallow-water survey methodology (SNH, 2008).

A general survey was made of the Burn of Norwick and its substrate types within the survey reaches; defined as 100m upstream and 500m downstream of the existing bridge crossing at Northdale. This was carried out by walking along the bank and/or by wading in the water using thigh waders. The aim was to identify specific areas that were most likely to harbour mussels using information on their habitat preferences from previous studies and experience. Once an apparently suitable area was found, the watercourse was entered at the nearest point and search conducted, concentrated in the most favourable substrate types so as to optimise search efficiency. The searches were conducted in the following manner to ensure compatibility with other surveys and the standard SNH recommended methodology (SNH, 2008):

- Searches were made using a glass-bottomed viewing bucket;

- Viewing was conducted under favourable conditions i.e. bright light, clear water, low flow regime;
- Searches were made in water sufficiently shallow for safe wading;
- Searches were made in an upstream direction, checking favourable sites e.g. in the shelter of cobbles, boulders or overhanging banks;
- Loose debris and trailing weed were moved gently aside but no disturbance of the river bed was required; and
- The substrate in each transect was recorded and classified using the standard Wentworth Scale (1922).

Mussel abundance categories

For conservation reporting purposes, standard criteria were used for describing the abundance and status of the pearl mussels in 50m x 1m transects, based on counts of visible mussels (Cosgrove *et al.* 2000a). Any description of the conservation status of a mussel population must refer to the current ability of that population to recruit juveniles. The relative abundance and status terms used in this report (Table 2) match those used in previous survey work are therefore based on the recommended SNH terminology and, importantly, are directly comparable to those used on all other Scottish pearl mussel Site Condition Monitoring assessments.

Table 2. Standard relative abundance terms and codes for 50m x 1m transect counts.

Visible mussels per 50m x 1m transect	**Terminology**	**Abundance code**
0	Absent	E
1-49	Rare	D
50-499	Scarce	C
500-999	Common	B
1000+	Abundant	A

Results

The Burn of Norwick was surveyed under SNH licence (No 33634) for freshwater pearl mussels in September 2018 by Dr Peter Cosgrove, a highly experienced freshwater pearl mussel surveyor. The water levels were low and clear and the weather was bright and clear providing ideal conditions throughout surveying. No live mussels or empty/dead freshwater pearl mussel shells were found within the 600m survey reach.

The Burn of Norwick is small, recently dredged permanent watercourse. It has a gentle gradient within the 600m survey reach. Sometime after 2010, the survey reach on the Burn of Norwick at Northdale was dredged. The resultant instream substrate habitat is dominated with fine sized silt/peat sediment (Table 3). The catchment lies within an area dominated by sheep grazing and degraded blanket bog on upslope hillsides. No host fish were recorded present during surveys.

Table 3. Typical Burn of Norwick typical habitat summary

Location surveyed			Substrate stability		Width		Depth	Land use/riparian vegetation
600m around bridge @ Northdale			Unstable		2m		0.25m	Grazing pasture
	Bedrock	**Boulder**	**Cobble**	**Pebble**	**Granule**	**C sand**	**F sand**	**Silt/ Peat**
Substrate					5%	5%	+	90%
Comments: Muddy, silty and dredged channel. Wholly unsuitable for freshwater pearl mussels.								

+ = present, but less than 5%.

Photo 1. Burn of Norwick, Northdale @ HP639138, September 2018.

DISCUSSION

Summary of results

The Burn of Norwick was surveyed using SNH recommended standard shallow-water methodologies under ideal survey conditions. The relative abundance and status of the watercourse was classified as E 'Absent'. The sample based survey methodology used does not search every square metre of stream bed, so it is conceivable that a small number of freshwater pearl mussels may have remained undetected somewhere within the survey reaches. However, the use of an experienced surveyor meant that all potentially suitable habitats were thoroughly searched. It is highly unlikely (although hypothetically possible) that freshwater pearl mussels occur in the surveyed reaches where no mussels were found.

These limitations would apply to any freshwater pearl mussel survey carried out using the standard methodologies because it is a sample-based survey and not a complete census. Such a census would require the destructive searching of all loose substrate, including all potentially suitable habitats to search for hidden mussels. Census work of this nature is not carried out in Scotland due to the endangered status of the species and its legal protection, as well as Health and Safety considerations.

Implications of results

There is no evidence that freshwater pearl mussels are present within the section of the Burn of Norwick surveyed. Consequently, there are no particular freshwater pearl mussel sensitivities that need to be considered further. Nevertheless, freshwater pearl mussels are highly sensitive to changes in water quality, and if present and undetected (and there is no evidence for this) it will be important to avoid any sources of pollution or runoff from the site during proposed works by following best practice pollution prevention measures when working around watercourses.

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Appendix 6.5 SaxaVord Spaceport AEE Chapter 9 Water

CHAPTER 9 WATER

9. Water

9. Water

9.1 Introduction

9.1.1 This chapter provides an assessment of the effects of the Proposed Project on hydrological and hydrogeological resources.

9.1.2 The Proposed Project comprises a launch area at Lamba Ness comprising three launch pad complexes, a satellite tracking station, launch vehicle integration buildings, roadways (largely re-using existing roads), fuel storage and ancillary infrastructure.

9.1.3 The Proposed Project will be operated to launch sub-orbital and orbital launch vehicles. Orbital launches will enter either polar or sun-synchronous, low-earth orbits. The layout of the spaceport allows for launches by multiple Launch Operators using a range of different launch vehicle types and is designed to accommodate launch vehicles up to 30 m in height. Launch vehicle widths are anticipated to be between 1–2 m and will not have additional boosters at the sides. Full details of the Proposed Project are provided in Chapter 3.

9.1.4 An assessment of the potential significant effects of the operation of the Proposed Project on the water environment has been undertaken, together with an assessment of the potential for any long-term or permanent alterations to the hydrological and hydrogeological regime.

9.1.5 For the purposes of this assessment, watercourses have been identified as those which appear on 1:25,000 scale Ordnance Survey mapping (Volume III Drawing 9.1). However, reconnaissance and survey work by the project civil engineers and ecologists has been also been undertaken and observations of watercourses and field drains made and taken into account.

9.2 Legislation, Policy and Guidelines

Legislation

Space Industry Act

9.2.1 The Space Industry Act (2018) regulates all spaceflight activities carried out in the United Kingdom, and associated activities. The Act requires any person or organisation to obtain the relevant licence to:

- launch a launch vehicle from the UK;
- return a launch vehicle launched elsewhere than the UK to the UK landmass or the UK's territorial waters;
- operate a satellite from the UK;
- conduct sub-orbital activities from the UK;
- operate a spaceport in the UK; or
- provide range control services from the UK.

9.2.2 As the Applicant wishes to operate a vertical launch spaceport (the SaxaVord Spaceport) and provide range control services (at the Launch and Range Control Centre, LRCC) they are required to apply for a both a spaceport licence and a range control licence. However, AEE is only relevant to applications for spaceport licences.

Space Industry Regulations 2021

9.2.3 The Space Industry Regulations 2021 (the Regulations) set out in more detail the requirements for each licence the Regulators Licensing rules, which specify what information the UK Civil Aviation Authority (CAA), the regulator, requires in support of an application.

Additional Legislation

9.2.4 With regard to hydrology, management of water-borne pollution and protection of natural heritage areas, the Scottish Environment Protection Agency (SEPA) has statutory obligations in terms of the management and control of pollution into water resources in Scotland. Where careful design has avoided sensitive receptors, it is reasonable to assume that the adoption of the SEPA's Good Practice Guidelines will, in general, prevent pollution to acceptable standards and make the majority of any 'significant' effects unlikely.

9.2.5 There is a range of environmental legislation that the Proposed Project must adhere to throughout its life cycle. Relevant legislation and guidance documents have been reviewed and taken into account as part of this hydrogeological and hydrological assessment. Key legislative drivers relating to the water environment which have been considered within this assessment are listed below:

- Control of Pollution Act 1974;
- Environmental Protection Act 1990;
- Environment Act 1995;
- Water Framework Directive 2000/60/EC;
- Groundwater Daughter Directive 2006/118/EC;
- Water Environment and Water Services (Scotland) Act (WEWSA) 2003;
- Water Environment (Controlled Activities) (Scotland) Regulations 2011 (as amended in 2018) (CAR);
- The Water Intended for Human Consumption (Private Supplies) (Scotland) Regulations 2017 (amends and revokes the Private Water Supplies (Scotland) Regulations 2006);
- The Flood Risk Management (Scotland) Act 2009; and,
- The Town and Country Planning (Environmental Impact Assessment) (Scotland) Regulations 2017.

9.2.6 The Water Framework Directive has been implemented in Scotland through WESWA and CAR. The primary objective of the Directive is for all surface and coastal water bodies to achieve good chemical and ecological status, and ground water bodies to achieve good quantitative and chemical status, by 2015 or 2021. This required assessment of a much wider set of water quality parameters than had previously been used. SEPA has published River Basin Management Plans (RBMPs) which detail the current and target status of water bodies, and the means of achieving these targets.

Policy

9.2.7 Scottish Planning Policy (SPP) (Scottish Government, 2014) identifies the range of considerations likely to be relevant to the determination of developments of the nature of the Proposed Project. These include effects on hydrology, the water environment and flood risk.

9.2.8 It also states that the planning system should '*promote protection and improvement of the water environment, including rivers, lochs, estuaries, wetlands, coastal waters and groundwater, in a sustainable and co-ordinated way*' (paragraph 194); and '*Development management decisions should take account of potential effects on landscapes and the natural and water environment, including cumulative effects*' (paragraph 202).

9.2.9 With respect to flooding, SPP paragraph 255 promotes a precautionary approach to flood risk from all sources and states that the planning system should prevent development which would have a significant probability of being affected by flooding or would increase the probability of flooding elsewhere. Paragraph 264 sets out aspects to be taken account for development management, in respect of flood risk. This includes consideration of the design and use of the Proposed Project. Paragraph 266 notes that Flood Risk Assessments should be required for development in the medium to high category of flood risk (annual probability of coastal or watercourse flooding is greater than 0.5% or 1:200 years).

9.2.10 The following Planning Advice Notes, issued by the then Scottish Executive, are also relevant to the assessments made in this chapter:

- Planning Advice Note 61: Planning and Sustainable Urban Drainage Systems, 2001; and,
- Planning Advice Note 79: Water and Drainage, 2006.

9.2.11 The Shetland Local Development Plan (Shetland Islands Council, 2014), identifies considerations relevant to the Proposed Project including:

- WD1 Flooding Avoidance;
- WD2 Waste Water;
- WD3 Sustainable Drainage Systems;
- NH1 International and National Designations; and
- NH7 Water Environment.

Guidance

Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018

9.2.12 The Department for Transport issued its document '*Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*' in 2021, clarifying the government's environmental objectives relating to spaceflight and associated activities in the UK:

The environmental objectives for spaceflight are:

- *Minimise emissions contributing to climate change resulting from spaceflight activities;*
- *Protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities;*
- *Protect people and wildlife from the impacts of noise from spaceflight activities;*
- *Protect the marine environment from the impact of spaceflight activities.*

Guidance for the Assessment of Environmental Effects

9.2.13 The CAA (July 2021) document Guidance for the Assessment of Environmental Effects (AEE) explains the process for completing an assessment of environmental effects as part of a licence application under the Space Industry Act.

9.2.14 The AEE Guidance requires that potential direct and indirect significant effects of proposed spaceflight activities on environmental features, including water, are considered. The guidance further requires that:

- Specific potential effects are identified and, where possible, quantified;

- The focus of the AEE should be on significant effects arising from the proposed activities;
- Applicants for a spaceport licence set an environmental budget, comprising a maximum number of launches per launch vehicle type which can take place over the course of a year that can be carried out in an environmentally sustainable manner, taking into account the cumulative effect of all launches; and
- The AEE must address a range of environmental topics, including water.

Pollution Prevention Guidance documents

9.2.15 A review plan for Pollution Prevention Guidance documents (PPGs) is currently underway by Natural Resources Wales (NRW), the Northern Ireland Environment Agency (NIEA) and the Scottish Environment Protection Agency (SEPA), replacing them with a replacement guidance series: Guidance for Pollution Prevention (GPPs). GPPs provide environmental good practice guidance for the whole UK, and environmental regulatory guidance directly to Northern Ireland, Scotland and Wales only.

9.2.16 The PPGs and GPPs include the documents referred to below, which are the principal documents used for guidance on preventing contamination of surface water. Those relevant to the Proposed Project include:

- PPG1: General guide to the prevention of pollution (EA, SEPA & EHSNI, 2013);
- GPP2: Above ground oil storage tanks (EA, SEPA & EHSNI, January 2018);
- GPP21: Pollution incidence response planning (EA, SEPA & EHSNI, 2017).

9.2.17 The following SEPA Guidelines are also relevant:

- Flood Risk and Planning Briefing Note (SEPA, 2014);
- Position Statement: The role of SEPA in natural flood management (SEPA, Feb, 2012);
- Technical flood risk guidance for stakeholders, version 12 (SEPA, May 2019);
- Land Use Planning System Guidance Note 31 (LUPS-GU31) - Guidance on Assessing the Impacts of Development Proposals on Groundwater Abstractions and Groundwater Dependent Terrestrial Ecosystems (SEPA, October 2014);
- The Water Environment (Controlled Activities) (Scotland) Regulations 2011 as amended in 2018 - A practical guide (SEPA, 2011 as amended in 2019);
- Environmental Quality Standards and Standards for Discharges to Surface Waters, Supporting Guidance (WAT-SG-53) (SEPA, 2020);
- Development of a groundwater vulnerability screening methodology for the Water Framework Directive, Project WFD28 Final Report (SEPA 2004); and,
- The River Basin Planning Strategy for the Scotland River Basin District (SEPA, 2009/2015).

9.2.18 Other relevant guidance includes:

- Private Water Supplies: Technical Manual, Scottish Executive, 2006; and
- UK Technical Advisory Group on the WFD (Water Transport Directive), UK Environmental Standards and Conditions Final Report, November 2013.

9.3 Consultation

9.3.1 Extensive statutory consultation in relation to the water environment was carried out during preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Where directly relevant to this AEE, consultation responses received during the SaxaVord Spaceport planning application period have been summarised in Table 9.1.

Table 9.1 Consultation Relevant to AEE

Consultee	Notes
Shetland Islands Council Environmental Health	Shetland Islands Council Environmental Health was consulted for information on any known private water supplies within 1 km of any of the Proposed Project boundaries. Shetland Islands Council confirmed that it holds no records of any private water supplies within this study area.
SEPA	SEPA was not directly consulted, however a database of regulatory information including water quality classifications, flood risk, historical landfill sites, waste sites, and authorised industrial process was obtained by AECOM (the project civil engineer) and has been reviewed.

9.4 Assessment Methodology and Significance Criteria

9.4.1 The following section sets out the approach that was followed to collect relevant baseline information and the methodology for assessing impacts and the significance of effects.

Environmental Zone of Influence

9.4.2 The hydrology study area incorporates the areas within the Proposed Project boundary, alongside consideration of hydrological effects up to one kilometre away. Consideration has also been given to the presence of any known private water supplies within one kilometre of the Proposed Project.

9.4.3 The criteria for defining the EZI with regard to hydrological resources have been established based on professional judgement and experience with regard to likely access and working areas, reference to SEPA guidance, and with due consideration to other relevant guidance on hydrological assessment. The extent of the hydrology study area or EZI is shown on Drawing 9.1.

Desk Study

9.4.4 Baseline conditions have been established primarily via desk-based research and has included the following:

- consultation with relevant regulatory authorities as described in Table 9.1 above;
- identification of the locations and characteristics of catchments and principal watercourses and waterbodies as shown on 1:25,000 scale OS mapping which may be affected by the Proposed Project;
- identification of SEPA/WFD watercourse and water body classifications;
- review of online SEPA flood mapping;
- review and collation of pertinent information on surface hydrology, flooding, climate etc.;
- review of geological mapping of the area, British Geological Survey, Geology of Britain Viewer, 1:50,000 scale;
- review of hydrogeological characteristics and groundwater resource;
- review of Private Water Supply records held by the Drinking Water Quality Regulator for Scotland (DWQR) and Shetland Islands Council;

- AECOM project drawing 0065 – Existing Watercourses & Drainage Ditches; and,
- AECOM report *Shetland Space Centre, Desk Study and Site Appraisal* (AECOM, 2019), which is included as Volume IV Technical Appendix 9.1 to this AEE Report.

9.4.5 Details of the Proposed Project relevant to the water environment have been provided by the project team, principally AECOM as the project civil engineer. Specifically, this includes the following:

- AECOM project drawings:
  - 0037(S) – Launch Site Layout
  - 0054(B) – Launch Pad 1 Drainage Strategy
  - 0056(C) – Transport Holding Building Drainage Strategy
  - 0057(C) – Assembly & Storage Area Proposed Drainage Strategy
  - 0060(C) – Launch Pad 3 Drainage Strategy
  - 0066(A) – Satellite Tracking Area Drainage Strategy
- AECOM report *Shetland Space Centre, Drainage Strategy Rev.4* (AECOM, 2020a), which is included as Volume IV Technical Appendix 9.2 to this AEE Report.

Site Visit and Surveys

9.4.6 As part of AECOM's site appraisal (as reported in the above-noted desk study and site appraisal report), AECOM staff undertook a detailed site walkover of the Proposed Project in November 2019. Photographs were taken and are included in the report with descriptions. Observations were made of extant buildings, other relic infrastructure, and former quarries. Ground conditions were also observed where possible, including along the sea cliffs and at the quarries, where the soil profile was reported to be clearly exposed. The presence and nature of watercourses and drainage ditches was also noted.

9.4.7 Subsequently, in October and November 2020, AECOM undertook a preliminary ground investigation at the Proposed Project, to determine the depth of peat, where present, and the nature of underlying deposits and depth to bedrock. This investigation comprised excavation of 42 trial pits and advancing 304 peat probes. Information from this investigation is included and referred to as appropriate within this chapter. Full details are provided in the AECOM report *Shetland Space Centre, Preliminary Ground Investigation – Factual Report* (AECOM, 2020b) which is included as Volume IV Technical Appendix 9.3 to this AEE Report.

9.4.8 As part of the ecological assessment for the Proposed Project, Alba Ecology undertook field surveys in July 2018, updated in July 2020. These included an extended Phase 1 Habitat survey, a National Vegetation Classification (NVC) survey, and protected species surveys. Alba undertook an assessment of potential Groundwater Dependent Terrestrial Ecosystems (GWDTE) as part of this work, as reported in Appendix 6.2.

9.4.9 No water quality monitoring has been undertaken, although this is not considered to be warranted at this stage and is not considered to materially affect the impact assessment.

Assessment of Potential Effect Significance

9.4.10 The characterisation of hydrological and hydrogeological sensitivities has been guided by the matrix presented in Table 9.2 below which lists the characterisation criteria.

Table 9.2 Hydrological and Hydrogeological Sensitivity

Sensitivity	Description
High	Areas containing hydrological features considered to be of international or national interest, for example Aquatic Natura 2000 sites, SACs (Special Areas of Conservation), SSSIs (Site of Special Scientific Interest). Highly permeable superficial deposits allowing free transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of High or Good Ecological Potential. High risk of flooding.
Medium	Moderately permeable superficial deposits allowing some limited transport of contaminants to groundwater and surrounding surface waters. Wetland/watercourse of Moderate Ecological Potential. Moderate risk of flooding.
Low	Low permeability superficial deposits likely to inhibit the transport of contaminants. Wetland/watercourse of Poor or Bad Ecological Potential or no WFD classification. Low risk of flooding.

9.4.11 The criteria for sensitivity have been developed based on a hierarchy of factors relating to quality of the aquatic environment including international and national designations, water quality information, watercourse status from the WFD review work undertaken to date by SEPA, consultations, site reconnaissance and the professional judgement of the assessment team.

9.4.12 The prediction and assessment of effects on hydrology and hydrogeology has been undertaken using a series of tables to document the various potential impacts from operation of the Proposed Project. Effects have been predicted for the Proposed Project based on the guideline criteria for impact magnitudes set out in Table 9.3 below.

Table 9.3 Impact Magnitude

Impact Magnitude	Guideline Criteria
High	Total loss of, or alteration to, key features of the baseline resource such that characteristics or quality would be fundamentally and irreversibly changed e.g. watercourse realignment.
Medium	Loss of, or alteration to, key features of the baseline resource such that characteristics or quality would be partially changed e.g., instream permanent bridge supports.
Low	Small changes to the baseline resource, which are detectable, but the underlying characteristics or quality of the baseline

Impact Magnitude	Guideline Criteria
	situation would be similar e.g. culverting of very small watercourses/drains.
Negligible	A very slight change from baseline conditions, which is barely distinguishable, and approximates to the 'no-change' situation.

9.4.13 The significance of the predicted effects has been assessed in relation to the sensitivities of the baseline resource and magnitude of predicted impacts. A matrix of significance has been developed to provide a consistent framework for evaluation and is presented in Table 9.4 below. Guideline criteria for the various categories of effect are included in Table 9.5 below.

Table 9.4 Effect Significance Matrix

	Sensitivity			
Magnitude	**High**	**Medium**	**Low**	**Not Sensitive**
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

Table 9.5 Effect Significance Categories

Significance	Definition	Guideline Criteria
Major	A fundamental change to the environment.	Changes in water quality or quantity affecting widespread catchments or groundwater reserves of strategic significance.
Moderate	A larger, but non-fundamental change to the environment.	Changes in water quality or quantity affecting part of a catchment or groundwaters of moderate vulnerability.
Minor	A small but detectable change to the environment.	Localised changes resulting in minor and reversible effects on surface and groundwater quality or habitats.
Negligible	No detectable change to the environment.	No effects on drainage patterns, surface and groundwater quality or aquatic habitat.

9.4.14 In the above classification, fundamental changes are those which are permanent, either adverse or beneficial, and would result in widespread change to the baseline environment. For the purposes of this assessment, those effects identified as being major or moderate have been evaluated as significant environmental effects.

9.4.15 These matrices have been used to guide the assessment, although they have been applied with a degree of flexibility, since the evaluation of effects will always be subject to location-specific characteristics which must be taken into account. For this reason, the evaluation of the significance of effects in particular will not always correlate exactly with the cells in the relevant matrix, especially where professional judgement and knowledge of local conditions may result in a slightly different interpretation of the impact concerned. Additionally, effects may be assessed as having a significance level between those noted above, i.e., Minor to Moderate, or Moderate to Major.

9.4.16 Cumulative effects have been accounted for through the prediction and evaluation of effects cumulatively with those which could arise as a result of operation of other developments (operational, consented or in planning) within the EZI.

Requirements for Mitigation

9.4.17 Proposed mitigation measures are presented within this chapter where the potential to affect sensitive hydrological or hydrogeological receptors has been predicted.

Assessment of Residual Effect Significance

9.4.18 An assessment of any predicted significant residual effects on sensitive hydrological or hydrogeological receptors, taking account of committed mitigation measures, is presented within this chapter.

9.5 Baseline Conditions

Geography and Topography

9.5.1 The Proposed Project is located on the peninsula known as Lamba Ness, on the north-east coast of the Island of Unst. The coastline which forms the north, east and south boundaries comprises high, rocky cliffs, rising from sea level to approximately 10 to 20 m Above Ordnance Datum (AOD) along the north and east of the site, and as high as 50 m AOD in the south.

9.5.2 The Proposed Project site is generally flat, with a very gentle overall rise towards the west across the main body, steepening towards the west end (the western edge being at approximately 65 m AOD). A small, low hill feature (31 m AOD) is located towards the east end of the peninsula.

Designated Sites

9.5.3 There are no statutorily designated sites relevant to hydrology or hydrogeology within the boundaries of the Proposed Project.

9.5.4 No internationally designated sites relevant to hydrology or hydrogeology (i.e. Special Areas of Conservation) are located within the EZI.

9.5.5 There is one relevant nationally designated site within the EZI:

- The Norwick Meadows SSSI is approximately 800 m south-west of the Proposed Project and is designated for sand dunes and valley fen.

9.5.6 There is no hydrological continuity between the Proposed Project and the Norwick Meadows SSSI, therefore potential impacts on this designated site arising from operation are scoped out of further assessment.

Hydrology

9.5.7 There are no major surface watercourses within the Proposed Project boundary.

9.5.8 A minor, unnamed watercourse rises in the central part of the Proposed Project site (west of The Garths) and flows north/north-east to the sea west of Skaw Banks. A small pond feature appears to be present along the course of this burn.

9.5.9 Three further drains/minor burns flow from the western part of the northern boundary, north/north-east to the sea at Sand of Inner Shaw. Another drain flows north to south across the far west end of the site. Several small ponds are located off-site to the north of the far west end, with map markings indicating these may be water-filled former quarries.

9.5.10 A small water body is present in the south-east of the Proposed Project site, called Loch of Lamba Ness. A second, unnamed pond is located approximately 300 m west of this. These ponds have no evident connection with any surface watercourses, so may be rainwater fed.

9.5.11 In addition to the above watercourses and water bodies identified from 1:25,000 scale OS mapping (as shown on Drawing 9.1), AECOM identifies a number of drainage ditches cut into the Proposed Project site, as shown in Figure 9-1 below. These are largely in the central part of the site, draining from south to north, with a small number draining southward to the sea.

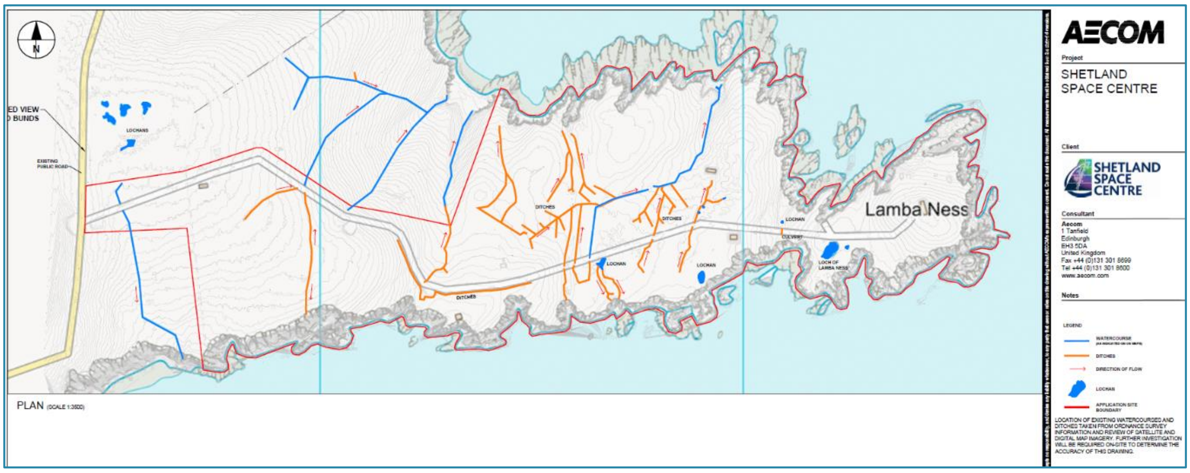

Figure 9-1 Existing watercourses and drainage ditches

9.5.12 Figure 9-1 also shows several additional small lochans, in the south-central part of the Proposed Project site.

9.5.13 Additional watercourses within 1 km of the Proposed Project are all up-stream/up-gradient and are therefore unlikely to be impacted by operation of the Proposed Project.

9.5.14 None of the above-noted watercourses have WFD classifications.

Summary

9.5.15 Although there are a number of drains and small watercourses within and near to the Proposed Project, these are all minor watercourses with no WFD classifications. Furthermore, they all drain to the sea, therefore the potential for any localised impact on surface water is minimal given the scale of the receiving coastal water body. The overall sensitivity of the hydrological (surface water) resource in the Proposed Project EZI is assessed as low.

Hydrogeology

Aquifer Status

9.5.16 The Hydrogeology Map of the UK indicates that the rock formations underlying the Proposed Project are classified as a low productivity aquifer, with flow virtually all through fractures and other discontinuities. Small amounts of groundwater may be present in the near-surface weathered zone.

9.5.17 SEPA identifies the groundwater body at the Proposed Project site as the Unst Groundwater (ID 150594), designated an overall status of '*Good*' in 2018.

Private Water Supplies

9.5.18 No springs or wells are marked on OS mapping within the boundary of the Proposed Project. A well is shown at the mouth of the Burn of Skaw, approximately 650 m north of the western part of the Proposed Project.

9.5.19 The DWQR online map shows no recorded private water supplies within 1 km of the Proposed Project. Shetland Islands Council has been consulted for any information it holds on private water supplies within 1 km of the Proposed Project. A response was received during the planning application stage indicating that Shetland Islands Council holds no records of private water supplies within the EZI.

Groundwater Dependent Terrestrial Ecosystems (GWDTE)

9.5.20 National Vegetation Classification (NVC) survey work undertaken by Alba Ecology (refer to Chapter 5) recorded several NVC communities indicative of potential groundwater dependence. Much of the Proposed Project area was recorded as wet modified bog and wet modified bog/wet heath transitional habitat, suggesting potentially moderate groundwater dependence.

9.5.21 Bedrock across the Proposed Project site comprises a low productivity aquifer (Skaw Intrusion), considered unlikely to contain any substantial groundwater at shallow depth. Groundwater is indicated to flow virtually all through fractures and other discontinuities. Therefore, the pattern of modified bog/wet heath being widespread across much of the site area is not indicative of potential groundwater presence along fissures or discontinuities. Rather, it is considered likely that these habitats are fed by rainwater forming waterlogged ground conditions.

9.5.22 An area of acid flush observed by Alba Ecology to the west of the Proposed Project site was identified as being potentially highly groundwater dependent. This area is within the Saxa Vord Pelite Formation, also a low permeability aquifer with minimal groundwater anticipated to be present at shallow depth. The localised occurrence of this habitat, near the edge of the Skaw Intrusion, suggests potential for it to be at a fissure or spring feature, and fed by groundwater. However, this location is up-gradient, and more than 250 m from any proposed infrastructure (the distance identified by SEPA as being a suitable buffer between GWDTE and even deep excavations).

Summary

9.5.23 Superficial geological deposits in the area are likely to be variable and potentially conducive to transmission of groundwater at least locally. However, the regional bedrock has low permeability and is likely to inhibit migration of groundwater and reduce its susceptibility to impact beyond a limited zone of influence. The only area of potential GWDTE considered to be actually fed by groundwater is more than 250 m from any proposed infrastructure.

9.5.24 The sensitivity of groundwater at the Proposed Project site is assessed as low.

Flood Risk

9.5.25 SEPA online flood risk mapping identifies no risk of fluvial or coastal flooding at the Proposed Project site. Potential surface water flood risk areas are limited to actual water bodies i.e., the Loch of Lamba Ness.

9.5.26 Given the absence of identified flood risk, the sensitivity of the Proposed Project to flood risk is assessed as low.

9.6 Receptors Brought Forward for Assessment

9.6.1 Following review and analysis of the hydrological and hydrogeological baseline as reported above, the following features/receptors have been taken forward for assessment:

- Local surface water including watercourses within the Proposed Project boundary.

9.7 Standard Mitigation

9.7.1 The following embedded mitigation measures, as detailed at project planning and design stage, are applicable to operation of the Proposed Project.

9.7.2 The AECOM Drainage Strategy report and associated drawings provide full details of the proposed arrangements for the management of drainage throughout the Proposed Project.

Surface Water

9.7.3 Each launch pad will comprise a concrete slab with a launch pit sunk into it, and a flame deflection culvert. The concrete slab will be surrounded on three sides by a wall to contain any deluge water, if required. The slab will fall towards the launch pit, such that any surface and deluge water will run-off into the launch pit. The launch pit is connected to a culvert via a manhole with a penstock valve permitting water to be diverted to an interceptor/storage tank (for collection and removal for off-site treatment) during fuelling and launch activities.

9.7.4 When no launch activities are in operation, the penstock valve on the launch pit will be maintained open such that rain water run-off from the launch pit will discharge into a filter trench prior to sea outfall.

9.7.5 Launch pad fuel storage areas will have a contained concrete surface with run-off into channels which will discharge into a full-retention alarmed interceptor, before discharging into either a filter drain or drainage ditch. The interceptor will be appropriately sized to accommodate a tanker cell burst.

Foul Drainage

9.7.6 Permanent welfare facilities will be provided at the Proposed Project. Foul drainage from these facilities will be collected through a small drainage network into a sewerage storage tank which will be emptied as required. Given the relatively infrequent use of the facilities (only during launch cycles and in preparation for them), AECOM notes that it is not considered feasible to use septic tanks or small treatment works. In future, as and when launch frequency increases such that there are consistent foul drainage flows, a septic tank is proposed to be added, with filter distribution pipework and final discharge to existing drainage ditches.

9.7.7 Temporary welfare facilities will be provided at each launch pad when in use (i.e., portable cabins, with tanks emptied as required).

Fuel Storage

9.7.8 Fuels and gases will not be permanently stored at the Proposed Project, rather they will be brought to the launch pads from external storage, via road haulage, as required.

9.7.9 Large volume fuel and gas containers will remain on their trailers for fuelling and de-fuelling. Small volumes of fuels and oils in containers will be off-loaded to the ground within the control areas of the launch pads, to facilitate electrical and mechanical support during launches. These will be stored in accordance with best practice procedures, including being kept within a designated storage site in appropriate impermeable bunded containers/areas.

Water Abstraction

9.7.10 No new on-site water abstraction is proposed. The volumes of water required for site operation are approximately 5,000 litres per launch/test, and it is proposed that water will be either sourced from a nearby MoD reservoir west/north-west of the Proposed Project site (subject to further assessment and appropriate authorisation), or tankered onto site as required. Rainwater harvesting is also being considered and will be used where available but is unlikely to reliably provide the volumes required for all functions. Very little potable water will be required for site operation, and due to the intermittent requirement, bottled water will be used.

9.8 Potential Effects

9.8.1 New structures and hardstanding at the Proposed Project have the potential to result in increased and concentrated surface water run-off, impacting on the water quality and flow rate of local drainage ditches and watercourses; however, these structures have all been assessed as part of the construction phase during the planning application and are therefore not required to be considered further for AEE.

9.8.2 Taking account of the embedded mitigation included in the design of the Proposed Project during the planning stages, the potential impact magnitude of operation of the Proposed Project is considered to be low, on a low sensitivity receptor. Therefore, there are **no significant effects** predicted.

9.9 Additional Mitigation

9.9.1 Potential effects have been assessed as not significant, with no additional mitigation therefore required.

9.10 Cumulative Assessment

9.10.1 Cumulative effects can be either inter-project or intra-project effects.

9.10.2 Inter-project cumulative effects are those where an environmental topic/receptor is affected by impacts from more than one project at the same time and the impacts act together. No consented or proposed developments with the potential to create cumulative effects on water have been identified in the EZI.

9.10.3 Intra-project cumulative effects are those where an environmental topic/receptor is affected by more than one impact from the same Proposed Project and the impacts act together. Given that none of the other environmental topics considered impact directly on water and the fact that containment will be in place during launches, it is considered that there is no potential for additive or intra-project cumulative effects.

9.11 Residual Effects

9.11.1 No additional mitigation is proposed therefore, residual effects are as per the potential effects described in Section 9.8 above. All residual effects considered in this assessment are assessed as being minor adverse and therefore there are considered to be **no significant effects**.

9.12 Summary

9.12.1 The Proposed Project comprises three launch pads and ancillary buildings and access infrastructure. The site is a relatively flat area on the Lamba Ness peninsula with high, rocky cliffs forming the north, east and south boundaries.

9.12.2 There are no statutorily designated sites relevant to hydrology or hydrogeology within Proposed Project boundary. The Norwick Meadows SSSI is approximately 800 m south-west of the Proposed Project and is designated for sand dunes and valley fen.

9.12.3 There is no hydrological continuity between the Proposed Project and the Norwick Meadows SSSI.

9.12.4 There are a number of drains and small watercourses within and near to the Proposed Project site, all of which drain into the sea.

9.12.5 Habitats indicative of potential moderate groundwater dependency have been identified across much of the Proposed Project site, although based on the site geology and the distribution of these habitats, they are interpreted as being surface water or rainwater fed. The only area of potential

GWDTE considered to be actually fed by groundwater is more than 250 m from any proposed infrastructure.

9.12.6 Likely operational effects include sedimentation or pollution of the water environment from surface runoff and fuel/chemical leaks and spills, and effects on the local groundwater quality and flow regime.

9.12.7 Embedded mitigation measures included in the design of the Proposed Project and operational control measures include no bulk storage of fuels at the Proposed Project and provision of appropriate spill control procedures alongside a suitable Drainage Strategy to control and treat surface and foul drainage.

9.12.8 No new on-site water abstraction is proposed. Water required for site operation will be sourced from a nearby MoD reservoir or tankered onto site as required.

9.12.9 The likely effects on hydrological and hydrogeological receptors, taking account of the embedded mitigation measures committed to during the planning stage, have been assessed as minor and **no significant effects**.

9.12.10 The significance of residual effects on hydrological and hydrogeological receptors is considered to be minor and **no significant effects**.

9.12.11 No cumulative effects on hydrology or hydrogeology are predicted.

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Appendix 7.1 Launch Emissions Assessment

1. Scope of Assessment

The scope of the assessment has included the following:

- Application of the method of assessment agreed in consultation with Shetland Islands Council during preparation and determination of the planning application for the SaxaVord SpacePort, where the Proposed Project will be operated.
- Identification of study area and air quality sensitive receptors.
- Collection of baseline Carbon Monoxide (CO) concentrations at the Proposed Project.
- Collection of emissions data from Orbex for the launch emissions from a 19 m long Orbex PRIME Launch Vehicle.
- Development of representative modelled scenario from Launch Pad 3.
- Development of a time-dependant puff model (duration of 15.5 s modelled as 16 s) of a jet release using ADMS 6 in a range of meteorological conditions and wind directions in typical UK and Shetland-specific wind speeds.
- Development of a time-integrated dose model to predict total dose of CO at the closest residential receptor during the lifetime of the puff release (calculated at 1-minute intervals after launch) using ADMS 6 in a range of meteorological conditions and wind directions.
- Conversion of total dose to 1-hour and 8-hour running mean concentrations for comparison with the relevant air quality standard (AQS) for CO for the protection of human health, (results presented in tables).
- Contour maps demonstrating the puff concentration at 1-minute intervals after the launch for the most frequent meteorological condition, using Unst average wind speeds; and
- Results.

2. Environmental Zone of Influence and Air Quality Sensitive Receptors

2.1.1 The closest air quality sensitive receptors in each direction from Launch Pad 3 were identified, and an EZI up to 4 km was defined to track the concentration of the puff release from launch until CO concentrations returned to normal ambient background levels under a range of meteorological conditions. The closest occupied sensitive receptor is Banks Cottage at Norwick which is 2440 m from Launch Pad 3. This is shown as R1 on Drawing 7.1.

3. Method of Assessment

3.1 Consultation with Shetland Islands Council

A Shetlands Islands Council Environmental Health officer was consulted on the proposed scope and approach of the air quality assessment for candidate launch vehicles during the preparation and determination of the planning application for the SaxaVord Spaceport, where the Proposed Project will be operated. Confirmation that the approach for the modelling of launch events was appropriate was received from a Senior Environmental Health Officer on 26th June 2020. The same approach has been adopted and revised to account for the specific emissions and time to reach 1000 ft of the Orbex PRIME Launch Vehicle.

3.2 Baseline CO Concentrations

There are no local monitoring stations measuring background concentrations of CO in the Shetland Islands. The background concentration of CO for the study area was therefore downloaded from the Defra background concentration maps (DEFRA, 2025) for Shetland based on 1km x 1km grid square values. The maximum background concentration of 0.051 mg/m^3 from the grid squares covering a 25 km^2 study area around the Proposed Project (NGR 462500,1211500-NGR 467500, 1216500) was used as a representative value across the EZI.

3.3 Launch Event Scenarios

The Orbex PRIME Launch Vehicle is approximately 19 m long and 1.45 m. It is a two-stage launch vehicle that will carry small satellites up to 180 kg to polar and sun synchronous orbits. Initially, suborbital trajectories are proposed as part of the ongoing development program and are therefore also covered by the AEE.

The CAA Environmental Assessment Requirements and Guidance for Airspace Change Proposals CAP 1616i (CAA, 2023) states that assessment of emissions on local air quality is required for any airspace change less than 1000 feet in altitude.

It is therefore only necessary for the AQIA to consider emissions from Launch Vehicles during the first stage burn as subsequent stages occur at significantly higher altitudes. This has been estimated to take a maximum of 15.5 seconds (modelled as 16 s) for the Orbex PRIME Launch Vehicle.

The emissions within 1000 ft are the same whether orbital or suborbital trajectories apply, therefore only one emissions scenario is included in this chapter.

The majority of emissions from burning this propellent are water vapour (H_2O) alongside much smaller quantities of carbon dioxide (CO_2) and CO. Emissions are via six identical nozzles directed vertically downwards towards a flame deflector, thus resulting in a horizontal jet release close to ground level.

Launch event greenhouse gas emissions (including CO_2) are quantified in Chapter 4.

To determine the maximum potential effects of emission from a launch event at a sensitive receptor, the assessment considers the effects of emissions from Launch Pad 3 at receptor R1, Banks Cottage, the closest emission-receptor relationship.

3.4 Emissions Data

The emissions data for each launch were confirmed by the Applicant and are summarised in Table 1.

Table 1-Rocket Emissions per launch (Stage 1 only)

Parameter	Orbex PRIME Launch Vehicle
Temperature (∘K)	commercially sensitive
Exit Diameter of each nozzle (m)	commercially sensitive
Dimensions of flame deflector (base & height)	4.6 m & 2.9 m
Exit area of flame deflector (m^2)	6.67*
Modelled Jet Diameter (m)	2.91
Exhaust gas density (kg/m^3)	0.9
Ignition to 1000 ft altitude (seconds)	commercially sensitive
Total Mass of CO emitted from per Stage 1 launch (kg)	commercially sensitive
Volume of gas emitted in Stage 1 launch (m^3)	commercially sensitive
Volume Flow Rate (m^3/s)	commercially sensitive
Jet Velocity at flame deflector (m/s)	commercially sensitive

* plume discharge area at ground level assumed = deflector base width 4.6m x 0.5(deflector height of 2.9 m)

3.5 Modelling Assumptions

The launch platform has a flame deflector underneath the Launch Vehicle exhaust jet which will direct the jet from the vertical to the horizontal plane. The flame deflector is 2.9 m high with a width of 4.6 m at the base. To model the exhaust jet as horizontal release at ground level, the source area has been calculated using the deflector width multiplied by half the deflector height to account for the 90° change in direction from a vertical downward release to a horizontal release. ADMS 6 has been used to model a horizontal jet release based at ground level. The modelled jet diameter has been calculation so that the jet release area is equal to the flame deflector source area. The height of the centre of the jet release is the radius of the modelled release above ground level i.e. 1.46 m above ground level. The duration of the release is 16 seconds with the exhaust gas volume flow rate, temperature and mass emissions of CO as specified in Table 1.

A schematic diagram of the launch platform demonstrating the assumed model setup is shown in Figure 1.

Figure 1 - Schematic of Launch Platform

3.5.1 Meteorological Conditions used in the Assessment

The ADMS 6 puff model has been run for a set of seven different meteorological conditions that correspond to seven atmospheric stability classes known as Pasquill-Gifford Stability Classes A-G.

Stability is the tendency of the atmosphere to resist or enhance vertical motion and thus turbulence and potential dispersion of pollutants released within it. Stability is related to both the change of temperature with height (influenced by cloud cover and solar radiation) and mechanical friction influenced by the wind speed together with surface characteristics (roughness). The stability class conditions range from very convective (turbulent) conditions with a high surface solar heat flux, low winds and cloudless skies, (A), through to neutral conditions which are prevailing for approximately 40-50% of the time in the UK with moderate wind speeds and partially cloudy skies, (D), to very stable (calm) conditions with low temperatures and low wind speeds typically associated with night time or winter conditions (G).

It is recognised that the wind speeds on Unst can be considerably higher than the average UK conditions, therefore a detailed analysis of available meteorological data from Baltisound Airport in Unst from 2020-2024 has been undertaken in order to determine the average wind speed in each of eight compass directions and the prevailing wind speed across all directions locally. This is summarised in Tables 2 and 3. The wind roses for each year are shown in Drawing 7.2.

Table 2- Analysis of Baltisound Wind Speed and Direction 2020-2024

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
2020					
north (337.5-22.5°)	852	9.7%	5.8	17.5	0.0
north-east (22.5-67.5°)	587	6.7%	6.4	17.0	0.5
east (67.5-112.5°)	715	8.2%	5.4	21.1	0.5
south-east (112.5-157.5°)	1025	11.7%	7.0	19.6	0.5
south (157.5-202.5°)	1746	19.9%	7.9	20.6	0.5
south-west (202.5-247.5°)	1426	16.3%	7.3	19.1	0.5
west (247.5-292.5°)	1521	17.4%	8.1	21.6	0.5
north-west (292.5-337.5°)	888	10.1%	6.1	18.0	0.5
Missing	0	0.0%			
Total	8760	100.0%			
2021					
north (337.5-22.5°)	1154	13.1%	6.0	19.1	0.0
north-east (22.5-67.5°)	739	8.4%	6.0	17.5	0.5
east (67.5-112.5°)	651	7.4%	5.6	19.6	0.5
south-east (112.5-157.5°)	782	8.9%	7.3	19.6	0.5
south (157.5-202.5°)	1666	19.0%	7.3	19.6	0.5
south-west (202.5-247.5°)	1136	12.9%	6.8	20.6	0.5
west (247.5-292.5°)	1525	17.4%	6.8	21.1	0.5
north-west	1131	12.9%	6.5	21.6	0.5

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
(292.5-337.5°)					
Missing	0	0.0%			
Total	8784	100.0%			
2022					
north (337.5-22.5°)	1115	12.7%	5.2	17.0	0.0
north-east (22.5-67.5°)	454	5.2%	6.8	15.5	0.0
east (67.5-112.5°)	460	5.3%	6.4	16.5	1.0
south-east (112.5-157.5°)	1085	12.4%	9.0	22.2	0.0
south (157.5-202.5°)	1943	22.2%	7.8	20.1	0.5
south-west (202.5-247.5°)	1348	15.4%	7.6	17.0	0.5
west (247.5-292.5°)	1514	17.3%	8.3	24.2	0.5
north-west (292.5-337.5°)	841	9.6%	7.9	24.7	0.5
Missing	0	0.0%			
Total	8760	100.0%			
2023					
north (337.5-22.5°)	1173	13.4%	5.3	20.1	0.0
north-east (22.5-67.5°)	775	8.8%	6.5	21.6	0.0
east (67.5-112.5°)	951	10.9%	6.4	23.7	0.5
south-east (112.5-157.5°)	1002	11.4%	7.6	17.5	0.5
south (157.5-202.5°)	1419	16.2%	7.3	17.0	0.5
south-west	913	10.4%	6.8	19.1	0.5

Wind Direction (sector °)	Humber of Hours per annum	Percentage of hours per annum	Average Wind Speed (m/s)	Maximum Wind Speed (m/s)	Minimum Wind Speed (m/s)
(202.5-247.5°)					
west (247.5-292.5°)	1391	15.9%	7.5	24.2	0.5
north-west (292.5-337.5°)	1136	13.0%	7.3	26.8	0.5
Missing	0	0.0%			
Total	8760	100.0%			
2024					
north (337.5-22.5°)	990	11.3%	6.4	16.0	0.0
north-east (22.5-67.5°)	500	5.7%	7.0	17.0	0.5
east (67.5-112.5°)	588	6.7%	5.8	19.1	0.5
south-east (112.5-157.5°)	1191	13.6%	7.4	17.0	0.5
south (157.5-202.5°)	1933	22.1%	7.5	20.6	0.5
south-west (202.5-247.5°)	1330	15.2%	7.5	20.6	0.5
west (247.5-292.5°)	1392	15.9%	8.2	26.8	0.5
north-west (292.5-337.5°)	836	9.5%	7.4	20.6	0.5
Missing	0	0.0%			
Total	8760	100.0%			

Table 3 – Average Unst Wind Speed by Direction

	(2020-2024
North (337.5-22.5°)	***5.74***
North-east (22.5-67.5°)	***6.53***
East (67.5-112.5°)	***5.95***
South-east (112.5-157.5°)	***7.67***

	(2020-2024
South (157.5-202.5°)	*7.56*
South-west (202.5-247.5°)	*7.20*
West (247.5-292.5°)	*7.76*
North-west (292.5-337.5°)	*7.04*

The number of hours that the wind speed was greater than 5 m/s was between 66 % and 73 % of each year.
The prevailing wind direction is from the south to the west, and Unst wind speeds are higher than UK averages, therefore the emissions from any launch event will most likely be directed out towards the sea, rapidly dispersed and pose no risk to any onshore sensitive receptors, however the potential effects at the closest onshore receptor have been assessed in all seven stability meteorological conditions A-G for each of the eight main 45° compass sectors in order to model the dispersion of the jet puff release in a range of meteorological conditions and predict the worst case impact at the nearest sensitive receptor R1. An additional direction of north-northeast (67.5°) has been added as this would send the release directly towards R1. The meteorological conditions used in the modelling assessment for each wind direction in Table 2 are summarised for the UK and Unst Average wind speeds in Table 4.

Table 4 – Modelled Meteorological Conditions for Eight Compass Wind Directions

Stability Class	UK Average Wind Speed (m/s)	Unst Average Wind Speed (m/s)	Surface Solar Heat Flux (W/m^2)	Atmospheric Boundary Layer Height (m)
A	1	0° = 6.2 45° = 6.3 67.5° = 6.24 90° = 5.6 135° = 7.8 180° = 7.5 225° = 6.8 270° = 7.7 315° = 6.7	113	1300
B	2		84	900
C	5		74	850
D	5		0	800
E	3		-10	400
F	2		-6	100
G	1		-6	100

4. Results

4.1 Calculation of Exposure Time to Release at Receptor R1

The total dose of CO due to emissions from a launch event from Launch Pad 3 was calculated at R1 for the seven stability classes (A-G) in nine wind directions with both UK and Unst average wind speeds.

The maximum period when the CO concentration was predicted to be detectible above background levels (a minimum increase of 0.005 mg/m^3 i.e., 10 % of background levels of 0.05 mg/m^3) at receptor R1 was 82 minutes in Stability Class A conditions using UK average wind speeds.

The maximum period when the CO concentration was predicted to be detectible above background levels (a minimum increase of 0.005 mg/m^3 i.e., 10 % of background levels of 0.05 mg/m^3) at receptor R1 was 14 minutes in Stability Class E conditions using Unst average wind speeds.

The start time and end time after launch of concentrations above 0.055 mg/m^3 at 2,440 m from Launch Pad 3 is shown in Table 5.

Table 5 – Duration of Concentration above Background at R1with east north-east winds

Stability Class	Time First above 0.056mg/m^3 (seconds)	Time Last above 0.056mg/m^3 (seconds)	Puff Lifetime Duration (seconds)	Puff Lifetime Duration (minutes)	Fraction of 1-hour
UK Average Wind Speeds					
A	720	5640	4920	82	1.37
B	540	2460	1920	32	0.53
C	300	600	300	5	0.08
D	300	540	240	4	0.07
E	300	780	480	8	0.13
F	480	540	60	1	0.02
G	960	1080	120	2	0.03
Unst Average Wind Speeds					
A	240	420	180	3	0.05
B	240	540	300	5	0.08
C	240	480	240	4	0.07
D	240	420	180	3	0.05
E	240	480	240	4	0.07
F	240	1080	840	14	0.23
G	240	960	720	12	0.20

The most frequently occurring stability condition in the UK is stability D. Figure 2 shows where the concentration at 2,440 m downwind of the launch site is first above the background concentration of 0.051 mg/m^3 at 240 s (four minutes) after the release and returned to the background concentration value at 420 s (seven minutes) after the release using Unst average wind speeds for stability D.

Each curve line in Figure 2 shows the predicted concentration with distance downstream at a particular period of time after the launch.

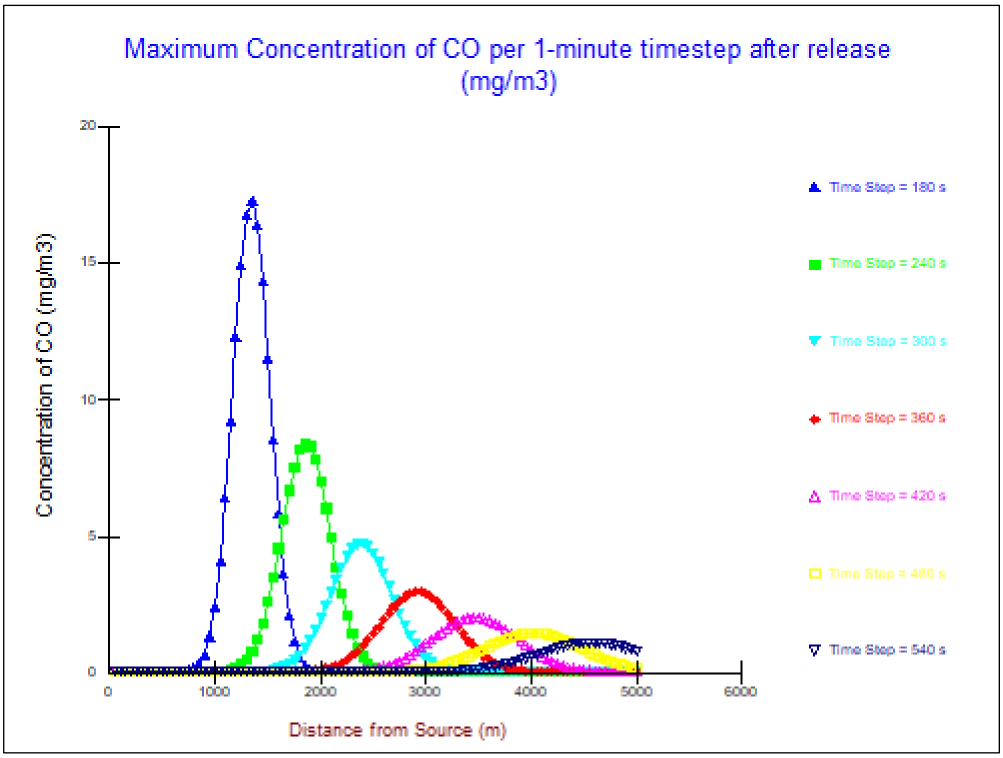

Figure 2 – One-Minute Timestep Concentrations of CO after Launch – Stability D

4.2 Calculation of 1-hour Average Concentration at Receptor R1

The ADMS 6 model was then used to calculate a total dose of CO at receptor R1, i.e., the total concentration that an individual would be exposed to over the lifetime of the puff (as detailed in Table 5) before it dispersed and ambient concentrations returned to normal background CO levels.

For each stability, the dose in mg.s/m^3 was divided by the puff lifetime (s) to calculate the average ambient concentration during the exposure period. Over one hour, the total concentration was calculated as the average puff lifetime concentration plus existing background for the duration of the puff i.e. for a fraction of 1 hour; and normal background concentration of 0.051 mg/m^3 for the remaining fraction of the hour.

For the most frequent meteorological condition of stability D with Unst average conditions, the puff lifetime was 180s (0.05 of 1 hour). The hourly average concentration was therefore calculated from the following equation:

Hourly average concentration = ((average puff lifetime concentration + 0.051) x 0.05 of hour) + (0.05 x 0.95 of hour).

4.3 Calculation of 8-hour Average Concentration at Receptor R1

To calculate the running 8-hour average, the concentration will be as background for the seven hours before release. Therefore, the maximum 8-hour average can be calculated from the following equation:

8-Hour average = (hourly average concentration + (7 x 0.051))/8

There will be no more than one test in any 24-hour period so the maximum 8-hour running mean can only be as above.

The results are summarised in Table 6 for UK average wind speeds for wind angles 0°, 45°, 67.5°, 90° and 135°. The results are summarised in Table 7 for Unst average wind speeds for wind angles 45°, 67.5° and 90°. For all other wind angles no change in background concentration was detected at R1.

Table 6 - Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – UK Average Wind Speeds

Stability Class	Maximum Dose at R1 ($mg.s/m^3$) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
Wind = 0 NORTH						
A	0.02	0.0001	0.051	0.05	0.05	0.51%
B	0.00	0.00	0.051	0.05	0.05	0.51%
C	0.00	0.00	0.051	0.05	0.05	0.51%
D	0.00	0.00	0.051	0.05	0.05	0.51%
E	0.00	0.00	0.051	0.05	0.05	0.51%
F	0.00	0.00	0.051	0.05	0.05	0.51%
G	0.00	0.00	0.051	0.05	0.05	0.51%
Wind = 45 NORTH-EAST						
A	97.73	0.05	0.051	0.10	0.06	0.60%
B	45.73	0.02	0.051	0.06	0.05	0.53%
C	2.09	0.01	0.051	0.05	0.05	0.51%
D	0.04	0.00	0.051	0.05	0.05	0.51%
E	0.06	0.00	0.051	0.05	0.05	0.51%
F	0.00	0.00	0.051	0.05	0.05	0.51%
G	0.01	0.00	0.051	0.05	0.05	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m³) UK average	Average Concentration over Exposure Period (mg/m³)	Background Concentration (mg/m³)	Maximum Hourly Average Concentration (mg/m³)	Maximum 8-Hour Average Concentration (mg/m³)	Percentage of the AQS
Wind = 67.5 EAST NORTH-EAST						
A	144.78	0.08	0.051	0.13	0.06	0.64%
B	225.30	0.12	0.051	0.11	0.06	0.59%
C	278.10	0.93	0.051	0.13	0.06	0.61%
D	336.29	1.40	0.051	0.14	0.06	0.63%
E	471.57	0.98	0.051	0.18	0.07	0.68%
F	191.57	3.19	0.051	0.10	0.06	0.58%
G	122.52	1.02	0.051	0.09	0.06	0.55%
Wind = 90 EAST						
A	112.47	0.02	0.051	0.07	0.06	0.55%
B	80.86	0.04	0.051	0.07	0.05	0.54%
C	11.96	0.04	0.051	0.05	0.05	0.52%
D	0.99	0.00	0.051	0.05	0.05	0.51%
E	1.53	0.00	0.051	0.05	0.05	0.51%
F	0.00	0.00	0.051	0.05	0.05	0.51%
G	0.28	0.00	0.051	0.05	0.05	0.51%
Wind = 135 SOUTH-EAST						
A	0.30	0.0001	0.051	0.05	0.05	0.51%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
B	0.00	0.00	0.051	0.05	0.05	0.51%
C	0.00	0.00	0.051	0.05	0.05	0.51%
D	0.00	0.00	0.051	0.05	0.05	0.51%
E	0.00	0.00	0.051	0.05	0.05	0.51%
F	0.00	0.00	0.051	0.05	0.05	0.51%
G	0.00	0.00	0.051	0.05	0.05	0.51%

Table 7 - Calculated Dose and 8-Hour Average CO Concentrations at Receptor R1 – Unst Average Wind Speeds

Stability Class	Maximum Dose at R1 (mg.s/m³) UK average	Average Concentration over Exposure Period (mg/m³)	Background Concentration (mg/m³)	Maximum Hourly Average Concentration (mg/m³)	Maximum 8-Hour Average Concentration (mg/m³)	Percentage of the AQS
Wind = 45 NORTH-EAST						
A	3.33	0.01	0.051	0.06	0.05	0.51%
B	1.07	0.00	0.051	0.05	0.05	0.51%
C	0.79	0.00	0.051	0.05	0.05	0.51%
D	0.02	0.00	0.051	0.05	0.05	0.51%
E	0.00	0.00	0.051	0.05	0.05	0.51%
F	0.00	0.00	0.051	0.05	0.05	0.51%
G	0.00	0.00	0.051	0.05	0.05	0.51%
Wind = 67.5 EAST NORTH-EAST						
A	219.03	0.73	0.051	0.78	0.06	0.56%
B	276.89	0.92	0.051	0.13	0.06	0.61%
C	291.39	1.21	0.051	0.13	0.06	0.61%
D	359.75	2.00	0.051	0.15	0.06	0.64%
E	429.25	1.79	0.051	0.17	0.07	0.66%
F	422.69	0.50	0.051	0.17	0.07	0.66%
G	427.21	0.59	0.051	0.17	0.07	0.66%

Stability Class	Maximum Dose at R1 (mg.s/m^3) UK average	Average Concentration over Exposure Period (mg/m^3)	Background Concentration (mg/m^3)	Maximum Hourly Average Concentration (mg/m^3)	Maximum 8-Hour Average Concentration (mg/m^3)	Percentage of the AQS
Wind = 90 EAST						
A	16.70	0.09	0.051	0.14	0.05	0.52%
B	8.93	0.03	0.051	0.05	0.05	0.52%
C	7.55	0.03	0.051	0.05	0.05	0.51%
D	0.77	0.00	0.051	0.05	0.05	0.51%
E	0.14	0.00	0.051	0.05	0.05	0.51%
F	0.00	0.00	0.051	0.05	0.05	0.51%
G	0.01	0.00	0.051	0.05	0.05	0.51%

It is possible for launch events to occur in higher wind speeds than the Unst averages that have been modelled. The calculated 8-hour average concentrations for comparison with the AQS are therefore conservative worse-case results.

The maximum predicted dose with Unst wind speeds at R1 was 429.25 mg.s/m^3 CO over 4 minutes. This is equivalent to a maximum dose over the lifetime of the jet release of 375 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of 4 minutes. A person would have to be exposed to this dose for two to three hours of constant exposure to experience headache or dizziness (Goldstein, 2008).

The maximum predicted 8-hour concentration at R1 was 0.068 mg/m^3, 0.68 % of the AQS, when modelled using UK average convective (Stability E) meteorological conditions with wind from the north north-east (67.5°). This reduced to 0.66% of the AQS when average Unst wind speed conditions were modelled for this direction.

On analysis of the meteorological data, a north north-east (67.5°) wind only occurs for approximately 8 % of the year on Unst.

Drawings 7.3 to 7.4 show the concentration contour plots of the puff as it moves downwind from after the start of the release for the most frequent stability condition and an east north-east wind using Unst average wind speeds. The concentration scale demonstrates how quickly the puff dilutes and disperses after release, with no concentrations above background levels by 480 s (eight minutes) after release.

5. Summary

The assessment has calculated the CO dose and average 8-hour concentration at the closest residential receptor (R1) to the Launch Pad 3 at the SaxaVord SpacePort at 1-minute intervals after a launch of an Orbex PRIME Launch Vehicle.

With the Unst average wind speeds, the modelling identified that the downwind concentration of CO was slightly detectible above background levels following launch for a period of up to 4 minutes after which time, concentrations reverted to background levels.

The maximum predicted dose with Unst wind speeds at R1 was 429.25 mg.s/m^3 CO over 4 minutes. This is equivalent to a maximum dose over the lifetime of the jet release of 375 parts per million (ppm). There are no health effects of this level of exposure to CO over periods of 4 minutes. A person would have to be exposed to this dose for two to three hours of constant exposure to experience headache or dizziness (Goldstein, 2008).

On analysis of the meteorological data, a north north-east (67.5°) wind only occurs for approximately 8 % of the year on Unst. There is therefore a high probability that launch events will take place under the local prevailing wind conditions which, over the period 2020-2024, were southerly to westerly. Under prevailing conditions, there is no detectible impact of launch emissions at the closest receptor R1 in UK or Unst average wind speed conditions.

The assessment has demonstrated that there is no risk of exceedance of the 8-hour AQS for CO at any sensitive receptor in the vicinity of the Proposed Project irrespective of the prevailing weather conditions during a launch event and there are no health effects associated with the maximum predicted dose of 375 ppm over 4 minutes.

6. References

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Appendix 8.1 BRRC Noise Modelling Report

Blue Ridge Research and Consulting, LLC

Technical Report

Noise Study for Launch Vehicle Operations at Shetland Space Centre

October 2, 2020 (Final)

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Acronyms and Abbreviations

The following acronyms and abbreviations are used in the report:

ASEL	A-Weighted Sound Exposure Level in Decibels
BRRC	Blue Ridge Research and Consulting, LLC
dB	Decibel
dBA	A-weighted Decibel Level
dBC	C-weighted Decibel Level
CDNL	C-weighted Day Night Average Sound Level
DI	Directivity Indices
DNL	Day Night Average Sound Level
DSM-1	Distributed Source Method 1
EIA	Environmental Impact Assessment
Hz	Hertz
km	Kilometers
$L_{A,max}$	Maximum A-weighted OASPL in Decibels
L_{den}	A-weighted Day-Evening-Night Sound Level in Decibels
L_{max}	Maximum Unweighted OASPL in Decibels
L_{pk}	Peak Sound Pressure Level in Decibels
N	Newtons
NIHL	Noise-Induced Hearing Loss
NIOSH	National Institute for Occupational Safety and Health
OASPL	Overall Sound Pressure Level in Decibels
OSHA	Occupational Safety and Health Administration
Pa	Pascal
psf	Pounds per Square Foot
RUMBLE	The Launch Vehicle Acoustic and Emissions Simulation Model
SEL	Sound Exposure Level
SCLV	Small Class Launch Vehicles
S.L.	Sea Level
TA	Time Above
UK	United Kingdom

1 Introduction

This report documents the noise study performed as part of efforts on the Environmental Impact Assessment (EIA) for proposed launch operations at Shetland Space Centre (SSC). SSC plans to conduct launch and static operations of various launch vehicles from three pads. Although a number of small class launch vehicles (SCLV) could operate from the proposed launch sites, this noise study examines a single nominal launch vehicle representing the largest SCLV (in terms of thrust) projected to be launched from SSC. The potential impacts from propulsion noise and sonic booms are evaluated in relation to human annoyance, hearing conservation, and structural damage.

This noise study describes the environmental noise associated with proposed operations. Section 2 describes the proposed operations at SSC; Section 3 summarizes the basics of sound and describes the noise metrics and impact criteria discussed throughout this report; Section 4 describes the general methodology of the propulsion noise and sonic boom modeling; and Section 5 presents the propulsion noise and sonic boom modeling results. A summary is provided in Section 6 to document the notable findings of this noise study.

Figure 1. Image of SSC launch site (credit: Shetland Space Centre Ltd)

2 Launch and Static Operations

SSC plans to conduct up to 30 launch and 30 static fire operations of various small class launch vehicles per year. The annual operations are presented in Table 1 in terms of acoustic time of day.

The representative SCLV length, diameter, weight, and sea level (S.L.) thrust are presented in Table 2. The noise and sonic boom modeling use the time varying weight and thrust profiles, with the first stage reaching a maximum thrust of 736,200 N.

Launch trajectories departing from SSC will be unique to the vehicle, mission, and environmental conditions. For the purposes of this study, the noise modeling utilized a nominal launch trajectory provided by the SCLV manufacturer with an azimuth of 343°, relative to true north. An overview of the facility and nominal trajectory from each pad is shown in Figure 2.

Table 1. Proposed SCLV operations

				Annual Operations			
Pad	**Coordinates**	**Event**	**Duration**	Daytime 0700 – 1900	Evening 1900 – 2300	Nighttime 2300 – 0700	Total
Pad 1	60.8188° N	Launch	--	6	2	2	10
(Eastern)	0.7751° W	Static Fire	5 seconds	6	2	2	10
Pad 2	60.8184° N	Launch	--	6	2	2	10
(Central)	0.7700° W	Static Fire	5 seconds	6	2	2	10
Pad 3	60.8178° N	Launch	--	6	2	2	10
(Western)	0.7613° W	Static Fire	5 seconds	6	2	2	10

Table 2. SCLV modeling parameters

Modeling Parameters	**Values**
Length	29 m
Diameter	1.8 m
Gross Mass	10,049 kg
Propellant Description	LOX/RP-1
S.L. Thrust	633,658 N (158,415 N/engine x Qty. 4 engines)

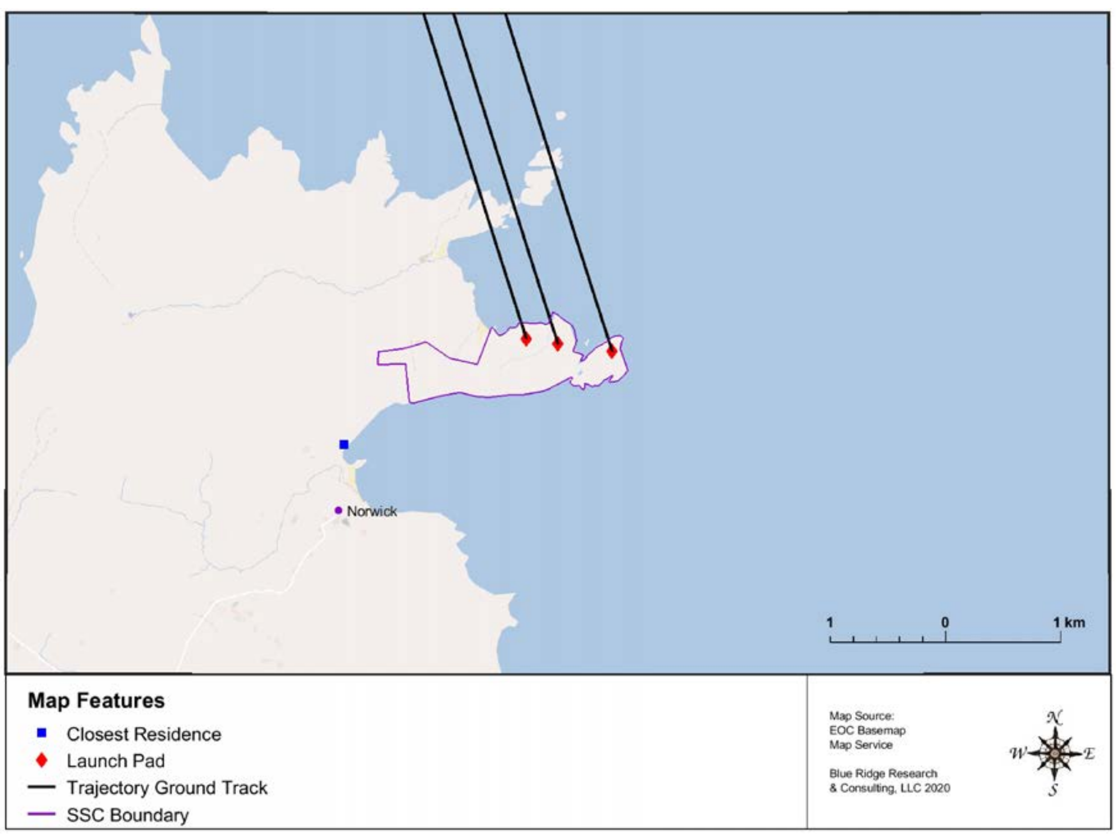

Figure 2. SSC facility boundary, launch pads, and trajectory ground tracks from each pad.

3 Acoustics Overview

An overview of sound-related terms, metrics, and effects, which are pertinent to this study, is provided to assist the reader in understanding the terminology used in this noise study.

3.1 Fundamentals of Sound

Any unwanted sound that interferes with normal activities or the natural environment is defined as noise. Three principal physical characteristics are involved in the measurement and human perception of sound: intensity, frequency, and duration [1].

- **Intensity** is a measure of a sound's acoustic energy and is related to sound pressure. The greater the sound pressure, the more energy is carried by the sound and the louder the perception of that sound.
- **Frequency** determines how the pitch of the sound is perceived. Low-frequency sounds are characterized as rumbles or roars, while high-frequency sounds are typified by sirens or screeches.
- **Duration** is the length of time the sound can be detected.

3.1.1 Intensity

The loudest sounds that can be comfortably detected by the human ear have intensities a trillion times higher than those of sounds barely audible. Because of this vast range, using a linear scale to represent the intensity of sound can become cumbersome. As a result, a logarithmic unit known as the decibel (abbreviated dB) is used to represent sound levels. A sound level of 0 dB approximates the threshold of human hearing and is barely audible under extremely quiet listening conditions. Normal speech has a sound level around 60 dB. Sound levels above 120 dB begin to be felt inside the human ear as discomfort. Sound levels between 130 and 140 dB are experienced as pain [2].

Because of the logarithmic nature of the decibel unit, sound levels cannot be simply added or subtracted and are somewhat cumbersome to handle mathematically. However, some useful rules help when dealing with sound levels. First, if a sound's intensity is doubled, the sound level increases by 3 dB, regardless of the initial sound level. For example:

$$50 \text{ dB} + 50 \text{ dB} = 53 \text{ dB, and } 70 \text{ dB} + 70 \text{ dB} = 73 \text{ dB.}$$

Second, the total sound level produced by two sounds with different levels is usually only slightly more than the higher of the two. For example:

$$50.0 \text{ dB} + 60.0 \text{ dB} = 60.4 \text{ dB.}$$

On average, a person perceives a change in sound level of about 10 dB as a doubling (or halving) of a sound's loudness. This relation holds true for both loud and quiet sounds. A decrease in sound level of 10 dB represents a 90% decrease in sound intensity but only a 50% decrease in perceived loudness because the human ear does not respond linearly [1]. In the community, "it is unlikely that the average listener would be able to correctly identify at a better than chance level the louder of two otherwise similar events which differed in maximum sound level by < 3 dB" [3].

The intensity of sonic booms is quantified with physical pressure units rather than levels. Intensities of sonic booms are traditionally described by the amplitude of the front shock wave, referred to as the peak overpressure. The peak overpressure is normally described in units of pounds per square foot (psf). The amplitude is particularly relevant when assessing structural effects as opposed to loudness or cumulative community response. In this study, sonic booms are quantified by either dB or psf, as appropriate for the particular impact being assessed [4].

3.1.2 Frequency

Sound frequency is measured in terms of cycles per second or hertz (Hz). Human hearing ranges in frequency from 20 Hz to 20,000 Hz, although perception of these frequencies is not equivalent across this range. Human hearing is most sensitive to frequencies in the 1,000 to 4,000 Hz range. Most sounds are not simple pure tones, but contain a mix, or spectrum, of many frequencies. Sounds with different spectra are perceived differently by humans even if the sound levels are the same. Weighting curves have been developed to correspond to the sensitivity and perception of different types of sound. A-weighting and C-weighting are the two most common weightings. These two curves, shown in Figure 3, are adequate to quantify most environmental noises. A-weighting puts emphasis on the 1,000 to 4,000 Hz range to match the reduced sensitivity of human hearing for moderate sound levels. For this reason, the A-weighted decibel level (dBA) is commonly used to assess community sound.

Very loud or impulsive sounds, such as explosions or sonic booms, can sometimes be felt, and they can cause secondary effects, such as shaking of a structure or rattling of windows. These types of sounds can add to annoyance and are best measured by C-weighted sound levels, denoted dBC. C-weighting is nearly flat throughout the audible frequency range and includes low frequencies that may not be heard but cause shaking or rattling. C-weighting approximates the human ear's sensitivity to higher intensity sounds. Note, "unweighted" sound levels refer to levels in which no weighting curve has been applied to the spectra. Unweighted levels are appropriate for use in examining the potential for noise impacts on structures.

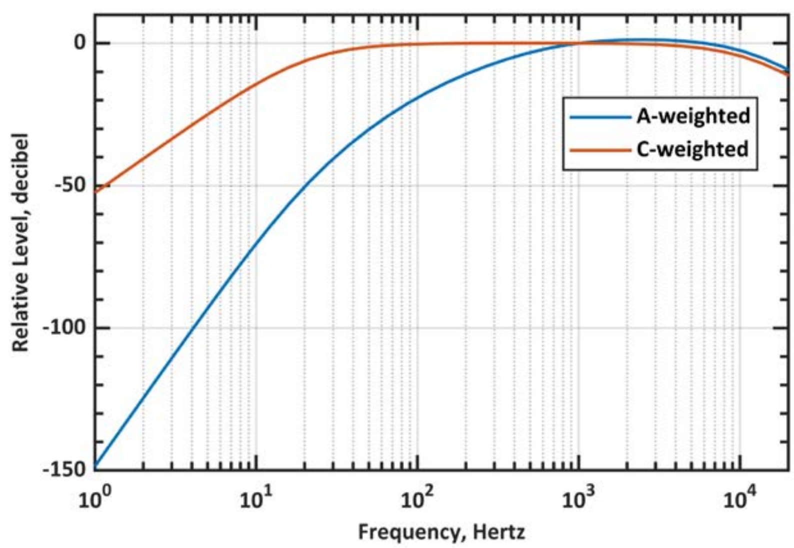

Figure 3. Frequency adjustments for A-weighting and C-weighting [5]

3.1.3 Duration

The third principal physical characteristic involved in the measurement and human perception of sound is duration, which is the length of time the sound can be detected. Sound sources can vary from short durations to continuous, such as back-up alarms and ventilation systems, respectively. Sonic booms are considered low-frequency impulsive noise events with durations lasting a fraction of a second. A variety of noise metrics have been developed to describe noise over different time periods. These are discussed in detail in Section 3.2.

3.1.4 Common Sounds

Common sources of noise and their associated levels are provided for comparison to the noise levels from the proposed action.

A chart of A-weighted sound levels from everyday sound sources [6] is shown in Figure 4. Some sources, like the air conditioners and lawn mower, are continuous sounds whose levels are constant for a given duration. Some sources, like the ambulance siren and motorcycle, are the maximum sound during an intermittent event like a vehicle pass-by. Other sources like "urban daytime" and "urban nighttime" (not shown in Figure 4) are averages over extended periods [7]. Per the US Environmental Protection Agency, "Ambient noise in urban areas typically varies from 60 to 70 dB but can be as high as 80 dB in the center of a large city. Quiet suburban neighborhoods experience ambient noise levels around 45-50 dB" [8].

A chart of typical impulsive events along with their corresponding peak overpressures in terms of psf and peak dB values are shown in Figure 5. For example, thunder overpressure resulting from lightning strikes at a distance of one kilometer is estimated to be near two psf, which is equivalent to 134 dB [9].

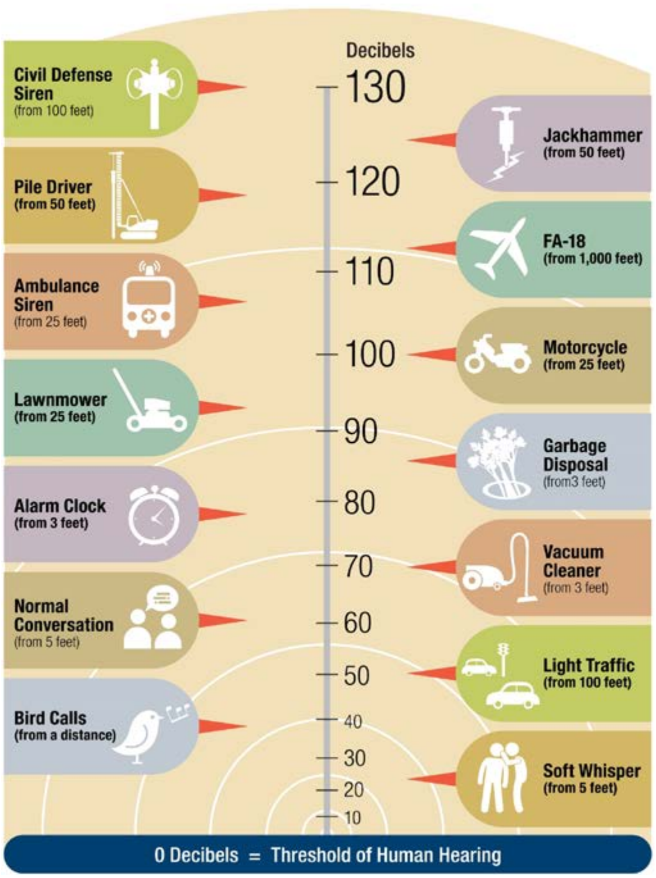

Figure 4. Typical A-weighted levels of common sounds [10]

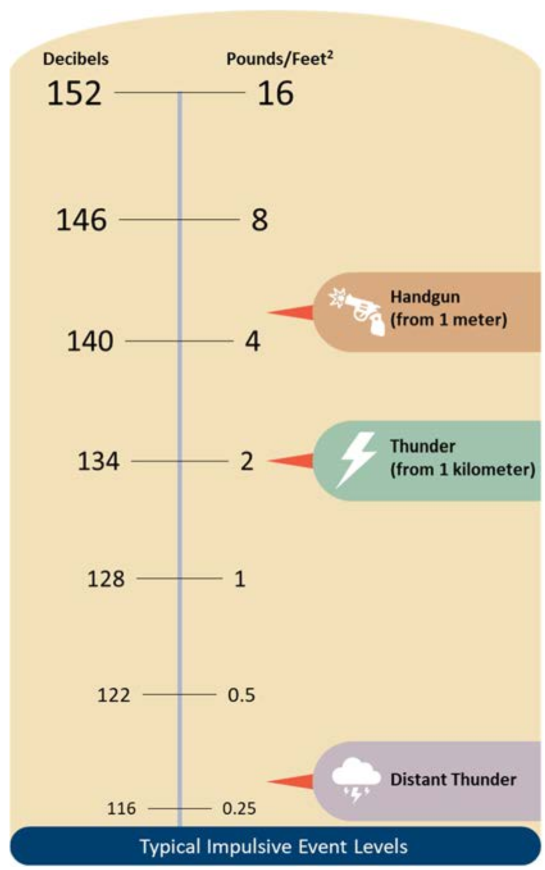

Figure 5. Typical impulsive event levels [9]

3.2 Noise Metrics

A variety of acoustical metrics have been developed to describe sound events and to identify any potential impacts to receptors within the environment. These metrics are based on the nature of the event and who or what is affected by the sound. A brief description of the noise metrics used in this noise study are provided below.

3.2.1 Maximum Sound Level (L_{max})

The highest unweighted sound level measured during a single event, in which the sound changes with time, is called the Maximum Sound Level (abbreviated as L_{max}). The highest A-weighted sound level measured during a single event is called the Maximum A-weighted Sound Level (abbreviated as $L_{A,max}$). Although it provides some measure of the event, L_{max} (or $L_{A,max}$) does not fully describe the sound because it does not account for how long the sound is heard.

3.2.2 Peak Overpressure (L_{pk})

For impulsive sounds, the true instantaneous peak sound pressure level, which lasts for only a fraction of a second, is important in determining impacts. The peak overpressure of the front shock wave is used to describe sonic booms, and it is usually presented in psf. Peak sound levels are not frequency weighted.

3.2.3 Day-Night Average Sound Level (DNL) and Day-Evening-Night Average Sound Level (L_{den})

Day-Night Average Sound Level is a cumulative metric that accounts for all noise events in a 24-hour period. To account for increased sensitivity to noise at night, DNL applies an additional 10 dB adjustment to events during the acoustical nighttime period, defined as 10:00 PM to 7:00 AM. DNL represents the average sound level exposure for annual average daily events.

The United Kingdom (UK) uses the Day-Evening-Night Average Sound Level (L_{den}), a variant of the DNL. In addition to a 10 dB (i.e. 10 times weighting) adjustment during the acoustical nighttime period (11:00 pm to 7:00 am), the L_{den} includes a 5 dB adjustment (i.e. 3 times weighting) to events during the acoustical evening period (7:00 PM to 11:00 PM) to account for decreased community noise during this period. DNL and L_{den} do not represent a level heard at any given time but represent long term exposure to noise.

3.2.4 Sound Exposure Level (SEL)

Sound exposure level 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 of time during which the event is heard. 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. Mathematically, it represents the sound level of a constant sound that would generate the same acoustical energy in one second as the actual time-varying noise event. For sounds that typically last more than one second, the SEL is usually greater than the L_{max} because a single event takes seconds and the maximum sound level (L_{max}) occurs instantaneously. A-weighted sound exposure level is abbreviated as ASEL.

3.2.5 Time Above (TA)

The Time Above a threshold level is a measure of the total time the noise level exceeds the A-weighted threshold level during a defined time period. TA is expressed in seconds and describes the time noise levels are elevated above a level. For example, TA66 represents the time that the noise levels are above 66 dBA. However, it does not describe the magnitude of the elevated noise levels.

3.3 Noise Effects

Noise criteria have been developed to protect the public health and welfare of the surrounding communities. The impacts of launch vehicle noise and sonic booms are evaluated on a cumulative basis in terms of human annoyance. In addition, potential impacts are evaluated on a single-event basis in relation to hearing conservation, sleep disturbance, speech interference, and structural damage.

3.3.1 Human Annoyance

DNL is based on long-term cumulative noise exposure and has been found to correlate well with long-term community annoyance for regularly occurring events including aircraft, rail, and road noise [11, 12]. Noise studies used in the development of the DNL metric did not include rockets, which are historically irregularly occurring events. Thus, it is acknowledged that the suitability of DNL for infrequent rocket noise events is uncertain. Additionally, it has been noted that the DNL "threshold does not adequately address the effects of noise on visitors to areas within a national park or national wildlife refuge where other noise is very low and a quiet setting is a generally recognized purpose and attribute" [13]. However, DNL is the most widely accepted metric to estimate the potential changes in long-term community annoyance. For launch propulsion noise, A-weighted DNL is used to assess the community impacts with regards to human annoyance. For impulsive noise sources with significant low-frequency content such as sonic booms, C-weighted DNL (CDNL) is preferred over A-weighted DNL [14]. In terms of percent highly annoyed, DNL 65 dBA is equivalent to CDNL 60 dBC [15]. Within the UK, the potential for community impacts with regards to human annoyance are assessed using L_{den} (see Section 3.2), a variant of DNL. Given that there are no formal thresholds incorporated into UK guidelines or legislation, the present study uses a criterion of 55 dBA L_{den} based on guidance from EU Directive 2002/49/EC [16].

3.3.2 Hearing Conservation

Launch Vehicle Noise

National agencies have provided guidelines on permissible noise exposure limits. These documented guidelines are in place to protect human hearing from long-term continuous daily exposures to high noise levels and aid in the prevention of noise-induced hearing loss (NIHL). A number of agencies have set exposure limits on non-impulsive noise levels, including the Occupational Safety and Health Administration (OSHA) [17], National Institute for Occupational Safety and Health (NIOSH) [18], and UK Legislation [19]. The most conservative of these upper noise level limits has been set by OSHA at 115 dBA. At 115 dBA, the allowable exposure duration is 15 minutes for OSHA and 28 seconds for NIOSH. $L_{A,max}$ contours are used to identify potential locations where hearing protection should be considered for rocket operations.

Sonic Booms

Multiple national agencies have provided guidelines on permissible noise exposure limits on impulsive noise such as sonic booms. In terms of upper limits on impulsive or impact noise levels, NIOSH [18], OSHA [20], and UK Legislation [19] have stated that levels should not exceed 140 dB peak sound pressure level, which equates to a sonic boom level of approximately 4 psf.

3.3.3 Sleep Disturbance

Launch Vehicle Noise

Sleep disturbance is a major concern for communities exposed to launch vehicle noise at night. A number of studies have attempted to quantify the effects of noise on sleep. Although no scientific evidence directly relates nighttime aircraft noise and irreversible long-term health effects such as stress-induced illnesses, sleep disturbance is a major cause of annoyance for the community.

The relationship between noise levels and sleep disturbance is complex and not fully understood. The disturbance depends not only on the depth of sleep, but also on the previous exposure to launch vehicle noise, familiarity with the surroundings, the physiological and psychological condition of the recipient, and a host of other situational factors. The most readily measurable effect of noise on sleep is the number of arousals or awakenings, and so the body of scientific literature has focused on predicting the percentage of the population that will be awakened at various single event noise levels, expressed in terms of SEL, and or the probability of awakening during the night from nighttime operations.

A UK study [21] concluded that "below outdoor event levels of 90 dB ASEL, aircraft noise events are most unlikely to cause any measurable increase in the overall rates of sleep disturbance experienced during normal sleep." An SEL of 90 dBA is used to identify potential locations where sleep disturbance may occur.

3.3.4 Speech Interference

Launch Vehicle Noise

Speech interference from noise is a primary cause of annoyance for communities. Disruption of routine activities such as radio or television listening, telephone use, or conversation leads to frustration and annoyance. The quality of speech communication is important in classrooms and offices. In the workplace, speech interference from noise can cause fatigue and vocal strain in those who attempt to talk over the noise. In schools it can impair learning.

There are two measures of speech comprehension:

1. Word Intelligibility - the percent of words spoken and understood. This might be important for students in the lower grades who are learning the English language, and particularly for students who have English as a Second Language.
2. Sentence Intelligibility – the percent of sentences spoken and understood. This might be important for high-school students and adults who are familiar with the language, and who do not necessarily have to understand each word in order to understand sentences.

A sentence intelligibility of 95% usually permits reliable communication because of the redundancy in normal conversation. Levels must remain below 66 dBA to maintain a speech intelligibility of 95% for two people standing outside, approximately 1 m apart [8].

3.3.5 Structural Damage

Launch Vehicle Noise

Typically, the most sensitive components of a structure to launch vehicle noise are windows, and infrequently, the plastered walls and ceilings. The potential for damage to a structure is unique interaction among the incident sound, the condition of the structure, and the material of each element and its respective boundary conditions. A report from the National Research Council on the "Guidelines for Preparing Environmental Impact Statements on Noise" [22] states that one may conservatively consider all sound lasting more than one second with levels exceeding 130 dB (unweighted) as potentially damaging to structures.

A NASA technical memo examined the relationship between structural damage claims and overall sound pressure level and concluded "the probability of structural damage [was] proportional to the intensity of the low frequency sound" [23]. This relationship estimated that one damage claim in 100 households exposed is expected at an average continuous sound level of 120 dB (unweighted), and one in 1,000 households at 111 dB (unweighted). The study was based on community responses to 45 ground tests of the first and second stages of the Saturn V rocket system conducted in Southern Mississippi over a period of five years. The sound levels used to develop the criteria were modeled mean sound levels.

It is important to highlight the difference between the static ground tests on which the rate of structural damage claims is based and the dynamic events modeled in this noise study. During ground tests, the engine/motor remains in one position, which results in a longer-duration exposure to continuous levels as opposed to the transient noise occurring from the moving vehicle during a launch event. Regardless of this difference, Guest and Slone's [23] damage claim criteria represents the best available dataset regarding the potential for structural damage resulting from rocket noise. Thus, L_{max} values of 120 dB (unweighted) and 111 dB (unweighted) are used in this report as conservative thresholds for potential risk of structural damage claims.

Sonic Booms

High-level sonic booms are also associated with structural damage. Most damage claims are for brittle objects, such as glass and plaster. Table 3 summarizes the threshold of damage that may be expected at various overpressures [24]. Additionally, Table 3 describes example impulsive events for each level range. A large degree of variability exists in damage experience, and much of the damage depends on the pre-existing condition of a structure. Breakage data for glass, for example, spans a range of two to three orders of magnitude at a given overpressure. The probability of a window breaking at 1 psf ranges from one in a billion [25] to one in a million [26]. These damage rates are associated with a combination of boom load and glass condition. At 10 psf, the probability of breakage is between one in 100 and one in 1,000. Laboratory tests involving glass [27] have shown that properly installed window glass will not break at overpressures below 10 psf, even when subjected to repeated booms. However, in the real world, glass is not always in pristine condition.

Damage to plaster occurs at similar ranges to glass damage. Plaster has a compounding issue in that it will often crack due to shrinkage while curing or from stresses as a structure settles, even in the absence of outside loads. Sonic boom damage to plaster often occurs when internal stresses are high as a result of these factors. In general, for well-maintained structures, the threshold for damage from sonic booms is 2 psf [24], below which damage is unlikely.

Table 3. Possible damage to structures from sonic booms [24]

Nominal level	Damage Type	Item Affected
0.5 – 2 psf *piledriver at construction site*	Plaster	Fine cracks; extension of existing cracks; more in ceilings; over doorframes; between some plasterboards.
	Glass	Rarely shattered; either partial or extension of existing.
	Roof	Slippage of existing loose tiles/slates; sometimes new cracking of old slates at nail hole.
	Damage to outside walls	Existing cracks in stucco extended.
	Bric-a-brac	Those carefully balanced or on edges can fall; fine glass, such as large goblets, can fall and break.
	Other	Dust falls in chimneys.
2 – 4 psf *cap gun/firecracker near ear*	Glass, plaster, roofs, ceilings	Failures show that would have been difficult to forecast in terms of their existing localized condition. Nominally in good condition.
4 – 10 psf *handgun at shooter's ear*	Glass	Regular failures within a population of well-installed glass; industrial as well as domestic greenhouses.
	Plaster	Partial ceiling collapse of good plaster; complete collapse of very new, incompletely cured, or very old plaster.
	Roofs	High probability rate of failure in nominally good state, slurry-wash; some chance of failures in tiles on modern roofs; light roofs (bungalow) or large area can move bodily.
	Walls (out)	Old, free standing, in fairly good condition can collapse.
	Walls (in)	Inside ("party") walls known to move at 10 psf.
> 10 psf *fireworks display from viewing stand*	Glass	Some good glass will fail regularly to sonic booms from the same direction. Glass with existing faults could shatter and fly. Large window frames move.
	Plaster	Most plaster affected.
	Ceilings	Plasterboards displaced by nail popping.
	Roofs	Most slate/slurry roofs affected, some badly; large roofs having good tile can be affected; some roofs bodily displaced causing gale-end and will-plate cracks; domestic chimneys dislodged if not in good condition.
	Walls	Internal party walls can move even if carrying fittings such as hand basins or taps; secondary damage due to water leakage.
	Bric-a-brac	Some nominally secure items can fall; e.g., large pictures, especially if fixed to party walls.

4 Noise Modeling

An overview of the propulsion noise and sonic boom modeling methodologies used in this noise study are presented in Section 4.1 and 4.2, respectively.

4.1 Propulsion Noise Modeling

Launch vehicle propulsion systems, such as solid rocket motors and liquid-propellant rocket engines, generate high-amplitude broadband noise. Most of the noise is created by the rocket plume interacting with the atmosphere and the combustion noise of the propellants. Although rocket noise radiates in all directions, it is highly directive, meaning that a significant portion of the source's acoustic power is concentrated in specific directions.

The Launch Vehicle Acoustic and Emissions Simulation Model (RUMBLE) 4.1, developed by Blue Ridge Research and Consulting, LLC (BRRC), is the noise model used to predict the noise associated with the proposed operations. The core components of the model are visualized in Figure 6 and are described in the following subsections.

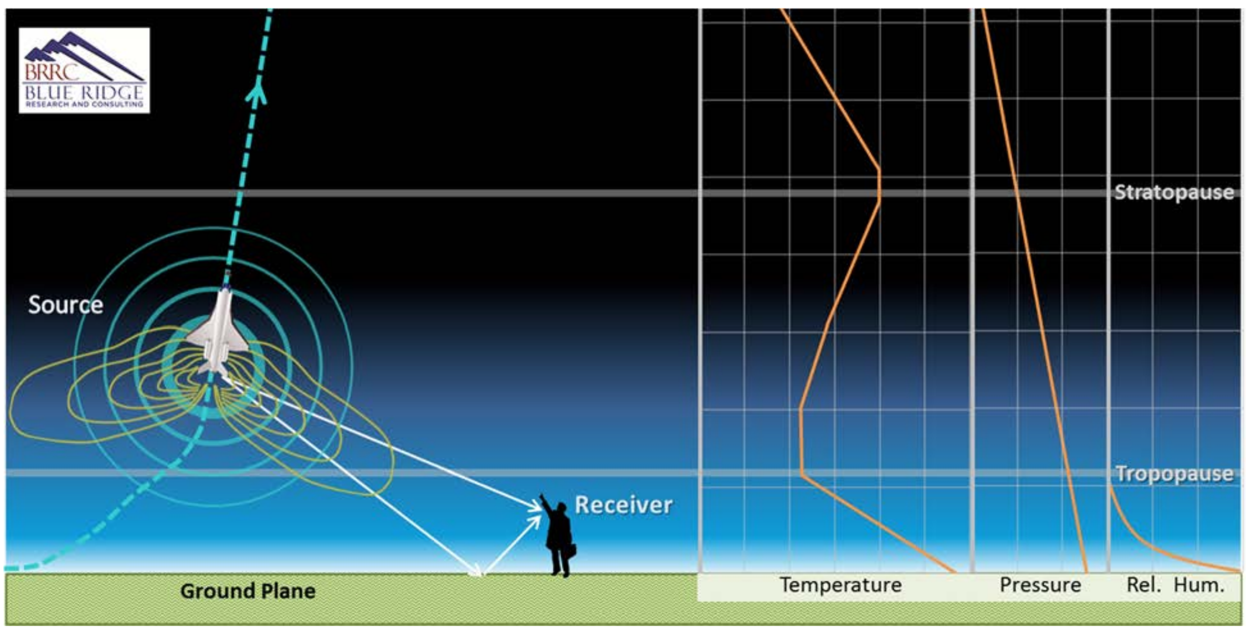

Figure 6. Conceptual overview of rocket noise prediction model methodology

4.1.1 Source

The rocket noise source definition considers the acoustic power of the rocket, forward flight effects, directivity, and the Doppler effect.

Acoustic Power

Eldred's Distributed Source Method 1 (DSM-1) [28] is utilized for the source characterization. The DSM-1 model determines the launch vehicle's total sound power based on its total thrust, exhaust velocity, and the engine/motor's acoustic efficiency. BRRC's recent validation of the DSM-1 model showed very good agreement between full-scale rocket noise measurements and the empirical source curves [29]. The acoustic efficiency of the rocket engine/motor specifies the percentage of the mechanical power converted into acoustic power. The acoustic efficiency of the rocket engine/motor was modeled using Guest's variable acoustic efficiency [30]. Typical acoustic efficiency values range from 0.2% to 1.0% [28]. In the far-field, distributed sound sources are modeled as a single compact source located at the nozzle exit with an equivalent total sound power. Therefore, launch vehicle propulsion systems with multiple tightly clustered equivalent engines can be modeled as a single engine with an effective exit diameter and total thrust [28]. Additional boosters or cores (that are not considered to be tightly clustered) are handled by summing the noise contribution from each booster/core.

Forward Flight Effect

A rocket in forward flight radiates less noise than the same rocket in a static environment. A standard method to quantify this effect reduces overall sound levels as a function of the relative velocity between the jet plume and the outside airflow [31, 32, 33, 34]. This outside airflow travels in the same direction as the rocket exhaust. At the onset of a launch, the rocket exhaust travels at far greater speeds than the ambient airflow. Conversely, for a vertical landing, the rocket exhaust and ambient airflow travel in opposing directions, yielding an increased relative velocity differential. As the differential between the forward flight velocity and exhaust velocity decreases, jet plume mixing is reduced, which reduces the corresponding noise emission. Notably, the maximum sound levels are normally generated before the vehicle reaches the speed of sound. Thus, the modeled noise reduction is capped at a forward flight velocity of Mach 1.

Directivity

Rocket noise is highly directive, meaning the acoustic power is concentrated in specific directions, and the observed sound pressure will depend on the angle from the source to the receiver. NASA's Constellation Program has made significant improvements in determining launch vehicle directivity of the reusable solid rocket motor (RSRM) [35]. The RSRM directivity indices (DI) incorporate a larger range of frequencies and angles than previously available data. Subsequently, improvements were made to the formulation of the RSRM DI [36] accounting for the spatial extent and downstream origin of the rocket noise source. These updated DI are used for this analysis.

Doppler Effect

The Doppler effect is the change in frequency of an emitted wave from a source moving relative to a receiver. The frequency at the receiver is related to the frequency generated by the moving sound source and by the speed of the source relative to the receiver. The received frequency is higher (compared to the emitted frequency) if the source is moving towards the receiver, it is identical at the instant of passing by, and it is lower if the source is moving away from the receiver. During a rocket launch, an observer on the ground will hear a downward shift in the frequency of the sound as the distance from the source to receiver increases. The relative changes in frequency can be explained as follows: when the source of the waves is moving toward the observer, each successive wave crest is emitted from a position closer to the observer than the previous wave. Therefore, each wave takes slightly less time to reach the observer than the previous wave, and the time between the arrivals of successive wave crests at the observer is reduced, causing an increase in the frequency. While they are traveling, the distance between successive wave fronts is reduced such that the waves "bunch together." Conversely, if the source of waves is moving away from the observer, then each wave is emitted from a position farther from the observer than the previous wave; the arrival time between successive waves is increased, reducing the frequency. Likewise, the distance between successive wave fronts increases, so the waves "spread out." Figure 7 illustrates this spreading effect for an observer in a series of images, where a) the source is stationary, b) the source is moving less than the speed of sound, c) the source is moving at the speed of sound, and d) the source is moving faster than the speed of sound. As the frequency is shifted lower, the A-weighting filtering on the spectrum results in a decreased A-weighted sound level. For unweighted overall sound levels, the Doppler effect does not change the levels since all frequencies are accounted for equally.

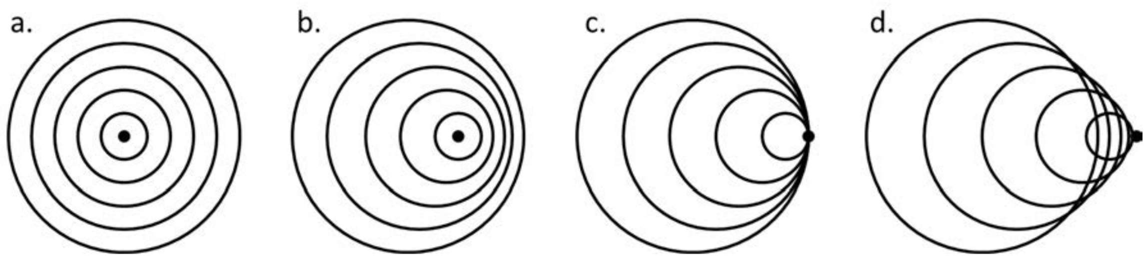

Figure 7. Effect of expanding wavefronts (decrease in frequency) that an observer would notice for higher relative speeds of the rocket relative to the observer for: a) stationary source b) source velocity < speed of sound c) source velocity = speed of sound d) source velocity > speed of sound

4.1.2 Propagation

The sound propagation from the source to receiver considers the ray path, atmospheric absorption, and ground interference.

Ray Path

The model assumes straight line propagation between the source and receiver to determine propagation effects. For straight rays, sound levels decrease as the sound wave propagates away from a source uniformly in all directions. The launch vehicle noise model components are calculated based on the specific geometry between source (launch vehicle trajectory point) to receiver (grid point). The position of the launch vehicle, described by the trajectory, is provided in latitude and longitude, defined relative to a reference system (e.g. World Geodetic System 1984) that approximates the Earth’s surface by an ellipsoid. The receiver grid is also described in geodetic latitude and longitude, referenced to the same reference system as the trajectory data, ensuring greater accuracy than traditional flat earth models.

Atmospheric Absorption

Atmospheric absorption is a measure of the sound attenuation from the excitation of vibration modes of air molecules. Atmospheric absorption is a function of temperature, pressure, and relative humidity of the air. The propulsion noise model utilizes an atmospheric profile, which describes the variation of temperature, pressure, and relative humidity with respect to the altitude. Standard atmospheric data sources [37, 38, 39, 40] were used to create a composite atmospheric profile for altitudes up to 106 km. The atmospheric absorption is calculated using formulas found in ANSI Standard S1.26-1995 (R2004). The result is a sound-attenuation coefficient, which is a function of frequency, atmospheric conditions, and distance from the source. The amount of absorption depends on the parameters of the atmospheric layer and the distance that the sound travels through the layer. The total sound attenuation is the sum of the absorption experienced from each atmospheric layer.

Nonlinear propagation effects can result in distortions of high-amplitude sound waves [41] as they travel through the medium. These nonlinear effects are counter to the effect of atmospheric absorption [42, 43]. However, recent research shows that nonlinear propagation effects change the perception of the received sound [44, 45], but the standard acoustical metrics are not strongly influenced by nonlinear effects [46, 47]. The overall effects of nonlinear propagation on high-amplitude sound signatures and their perception is an ongoing area of research, and it is not currently included in the propagation model.

Ground Interference

The calculated results of the sound propagation using DSM-1 provide a free-field sound level (i.e. no reflecting surface) at the receiver. However, sound propagation near the ground is most accurately modeled as the combination of a direct wave (source to receiver) and a reflected wave (source to ground to receiver) as shown in Figure 6. The ground will reflect sound energy back toward the receiver and interfere both constructively and destructively with the direct wave. Additionally, the ground may attenuate the sound energy, causing the reflected wave to propagate a smaller portion of energy to the receiver. RUMBLE accounts for the attenuation of sound by the ground [48, 49] when estimating the received noise. The model assumes a five-foot receiver height and a homogeneous grass ground surface. However, it should be noted that noise levels may be 3 dB louder over water surfaces compared to the predicted levels over the homogeneous grass ground surfaces assumed in the modeling. To account for the random fluctuations of wind and temperature on the direct and reflected wave, the effect of atmospheric turbulence is also included [48, 50].

4.1.3 Receiver

The received noise is estimated by combining the source and propagation components. The basic received noise is modeled as overall and spectral level time histories. This approach enables a range of noise metrics relevant to environmental noise analysis to be calculated and prepared as output.

4.2 Sonic Boom Modeling

A vehicle creates sonic booms during supersonic flight. The potential for the boom to intercept the ground depends on the trajectory and speed of the vehicle as well as the atmospheric profile. The sonic boom is shaped by the physical characteristics of the vehicle and the atmospheric conditions through which it propagates. These factors affect the perception of a sonic boom. The noise is perceived as a deep boom, with most of its energy concentrated in the low frequency range. Although sonic booms generally last less than one second, their potential for impact may be considerable.

A brief sonic boom generation and propagation modeling primer is provided in Section 4.2.1 to describe relevant technical details that inform the sonic boom modeling. The primer also provides visualizations of the boom generation, propagation, and ground intercept geometry. An overview of the sonic boom modeling software used in the study, PCBoom, and a description of inputs are found in Section 4.2.2.

4.2.1 Primer

When a vehicle moves through the air, it pushes the air out of its way. At subsonic speeds, the displaced air forms a pressure wave that disperses rapidly. At supersonic speeds, the vehicle is moving too quickly for the wave to disperse, so it remains as a coherent wave. This wave is a sonic boom. When heard at ground level, a sonic boom consists of two shock waves (one associated with the forward part of the vehicle, the other with the rear part) of approximately equal strength. When plotted, this pair of shock waves and the expanding flow between them has the appearance of a capital letter “N,” so a sonic boom pressure wave is usually called an “N-wave.” An N-wave has a characteristic "bang-bang" sound that can be startling. Figure 8 shows the generation and evolution of a sonic boom N-wave under the vehicle.

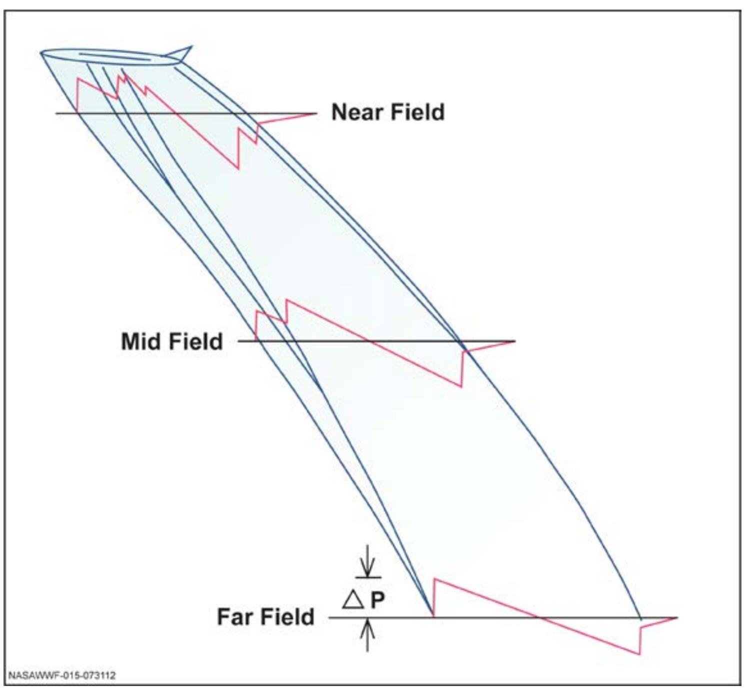

Figure 8. Sonic boom generation and evolution to N-wave [51]

For aircraft, the front and rear shock are generally the same magnitude. However, for rockets, in addition to the two shock waves generated from the vehicle body, the plume itself acts as a large supersonic body, and it generates two additional shock waves (one associated with the forward part of the plume, the other with the rear part) and extends the waveform duration to as large as one second. If the plume volume is significantly larger than the vehicle, its shocks will be stronger than the shocks generated by the vehicle.

Figure 9 shows the sonic boom wave cone generated by a vehicle in steady (non-accelerating) level supersonic flight. The wave cone extends toward the ground and is said to sweep out a "carpet" under the flight track. The boom levels vary along the lateral extent of the "carpet" with the highest levels directly underneath the flight track and decreasing levels as the lateral distance increases to the cut-off edge of the "carpet."

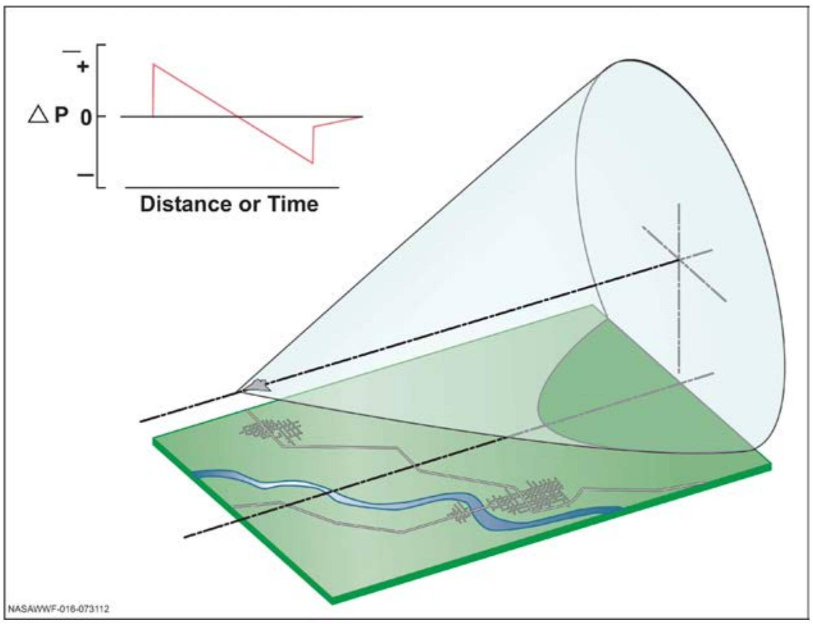

Figure 9. Sonic boom carpet for a vehicle in steady flight [52]

Although the wave cone can be calculated from an aircraft-fixed reference frame, the ray perspective is more convenient when computing sonic boom metrics in a ground-fixed observer's reference frame [53]. Both perspectives are shown in Figure 10. The difference in wave versus ray perspectives is described for level, climbing, and diving flight, in the PCBoom Sonic Boom Model User Guide [53]:

> Sonic boom wave cones are not generated fully formed at a single point in time, instead resulting from the accumulation of all previous disturbance events that occurred during the vehicle's time history. […] Unlike wave cones, ray cones are fully determined at a single point in time and are independent of future maneuvers. They are orthogonal to wave cones and represent all paths that sonic boom energy will take from the point they are generated until a later point in time when they hit the ground. The ray perspective is particularly useful when considering refraction due to atmospheric gradients or the effect of aircraft maneuvers, where rays can coalesce into high amplitude focal zones.

When the ray cone hits the ground, the resulting intersection is called an “isopemp.” The isopemp is forward-facing [as shown in Figure 10] and falls a distance ahead of the vehicle called the “forward throw.” At each new point in the trajectory, a new ray cone is generated, resulting in a new isopemp that strikes the ground. These isopemps are generated throughout the trajectory, sweeping out an area called the “boom footprint.”

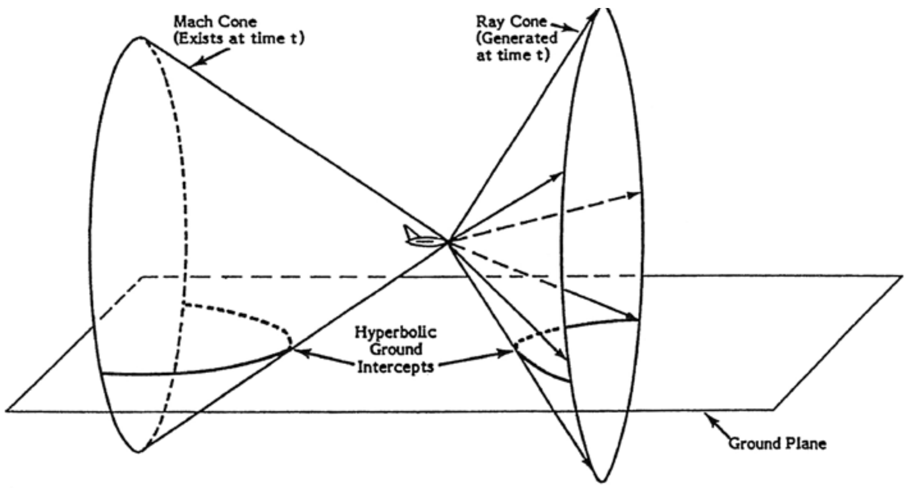

Figure 10. Mach cone vs ray cone viewpoints

Figure 9 and Figure 10 may give the impression that the boom footprint is generally associated with rays generated from the bottom of a vehicle. This is the case for vehicles at moderate climb and dive angles, or in level flight as shown in Figure 10. For a vehicle climbing at an angle steeper than the ray cone half angle, such as in the left image of Figure 11, rays from that part of its trajectory will not reach the ground. This is important for vertical launches, where the ascent stage of a launch vehicle typically begins at a steep angle. In these cases, sonic booms are not expected to reach the ground unless refracted back downwards by gradients in the atmosphere. Conversely, if a vehicle is in a sufficiently steep dive, such as in the right image of Figure 11, the entire ray cone may intersect the ground, resulting in an elliptical or even circular isopemp. This is of importance for space flight reentry analysis, where descent may be nearly vertical.

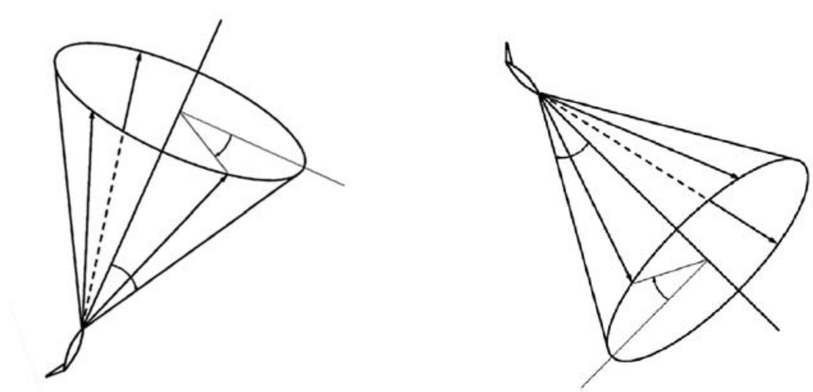

Figure 11. Ray cone in climbing (left) and diving (right) flight

4.2.2 PCBoom

The single-event prediction model, PCBoom 6.7b [54, 55, 56], is a full ray trace sonic boom program that is used to calculate the magnitude, waveform, and location of sonic boom overpressures on the ground from supersonic flight operations. Additionally, BRRC uses a custom version of PCBoom 6.7b that implements proper plume physics.

Several inputs are required to calculate the sonic boom impact, including the geometry of the vehicle, the trajectory path, and the atmospheric conditions. These parameters along with time-varying thrust, drag, and weight are used to define the PCBoom starting signatures used in the modeling. The starting signatures are propagated through a site-specific atmospheric profile that includes the mean temperature, wind speed, and wind direction [57].

5 Results

The following sections present the results of the environmental propulsion noise and sonic boom impacts associated with the proposed SCLV operations. Additionally, noise levels over water may be higher because of the acoustical hardness of the water surface. Single event propulsion noise and sonic boom noise metrics are presented in Section 5.1 and Section 5.2, respectively. Cumulative launch vehicle noise results are presented in Section 5.3.

5.1 Single Event Propulsion Noise Metrics and Effects

Single event propulsion noise events are evaluated using maximum A-weighted and unweighted levels, A-weighted sound exposure level, and time above.

5.1.1 Maximum A-weighted Sound Level ($L_{A,max}$)

The modeled $L_{A,max}$ contours associated with SCLV operations from SSC are presented in Figure 12 through Figure 17. An upper limit noise level of 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. There are no residences within the land area encompassed by the 115 dB noise contours resulting from SCLV operations. Thus, the potential for impacts to people in the community with regards to hearing conservation is negligible.

Launch Operations – The 115 dBA contour for SCLV launch events from Pad 1, Pad 2, and Pad 3 are shown in Figure 12, Figure 13, Figure 14, respectively. The SCLV launch event generates modeled levels at or above an $L_{A,max}$ of 115 dBA within 0.56 km of the pad nearest to the community.

Static Operations – The 115 dBA contour for SCLV static events from Pad 1, Pad 2, and Pad 3 are shown in Figure 15, Figure 16, and Figure 17, respectively. Note the difference in zoom level between the launch and static operation results. The SCLV static event noise contours are more directive than the launch event noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located along the peak directivity angle may experience an $L_{A,max}$ of 115 dBA at approximately 0.29 km from the pad during a static event. The levels produced by static events will remain constant over the duration of the event, whereas the levels produced by launch events will decrease as the rocket moves further away from the receptor.

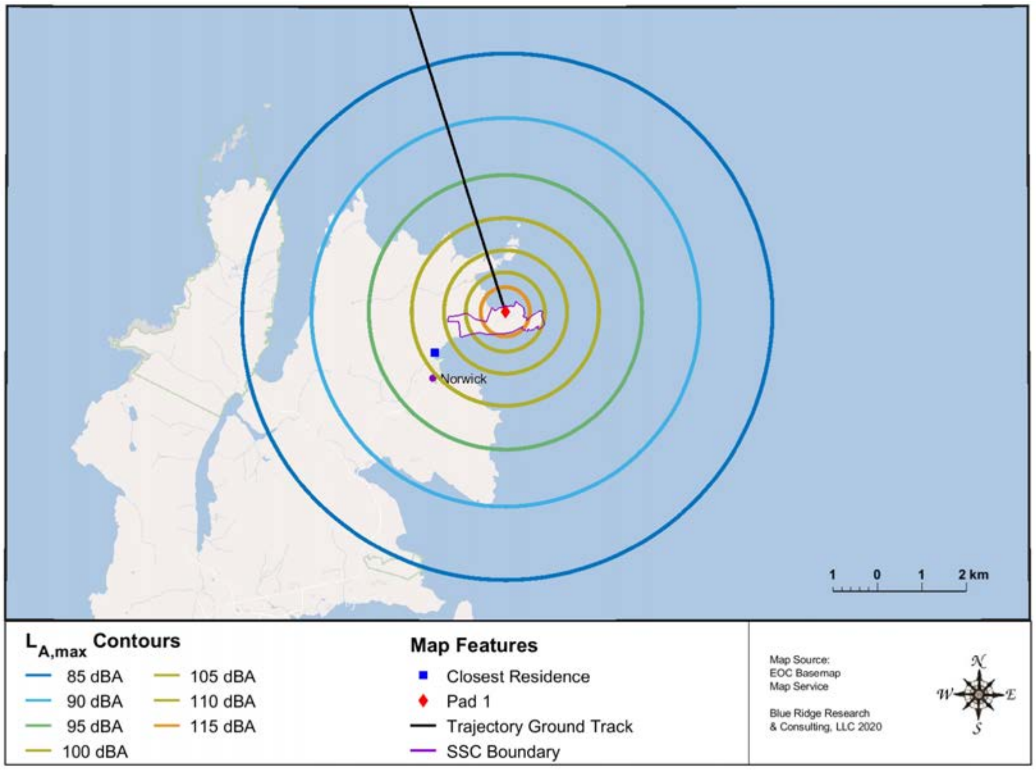

Figure 12. $L_{A,max}$ contours for a SCLV launch from SSC Pad 1

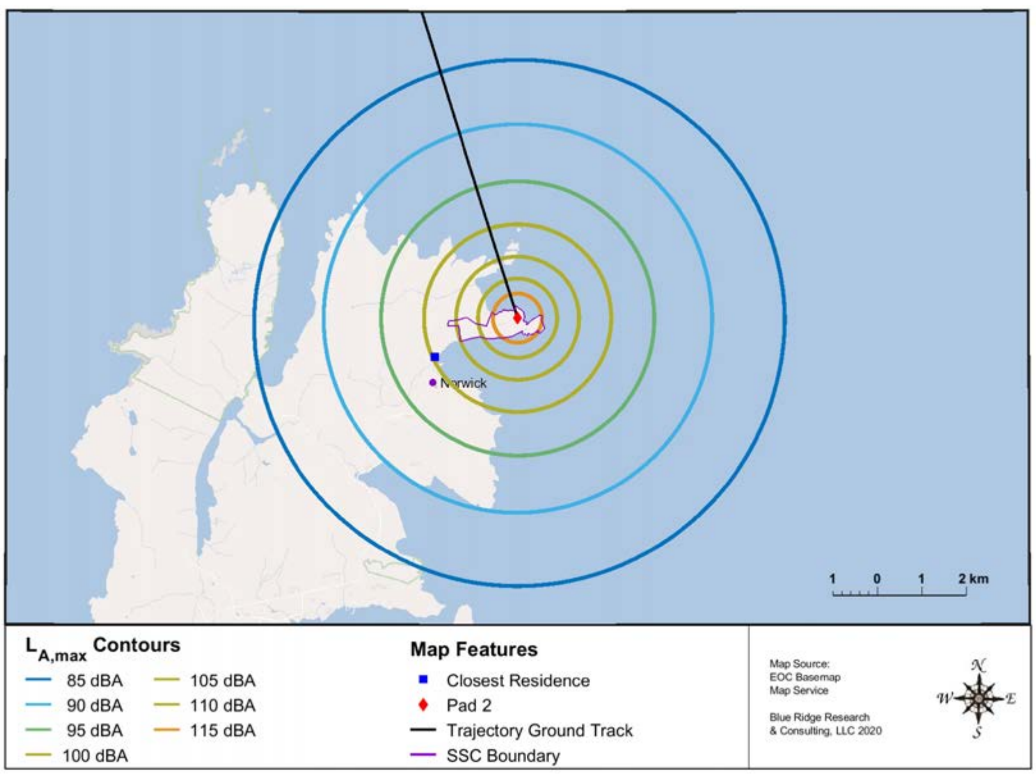

Figure 13. $L_{A,max}$ contours for a SCLV launch from SSC Pad 2

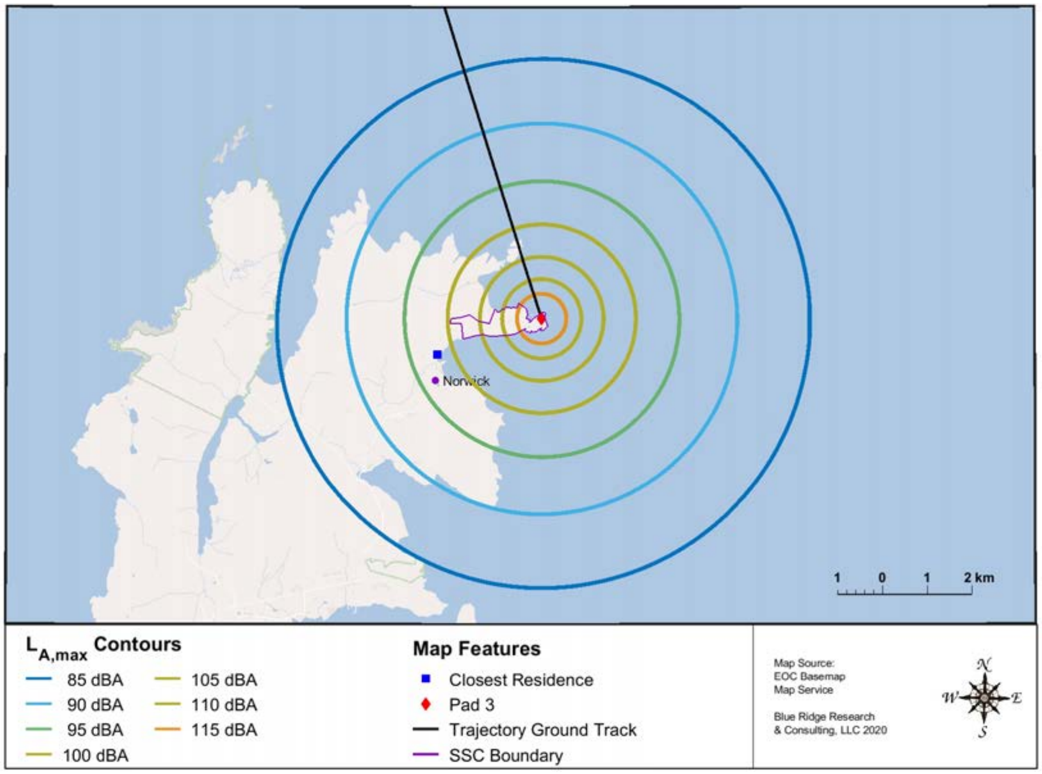

Figure 14. $L_{A,max}$ contours for a SCLV launch from SSC Pad 3

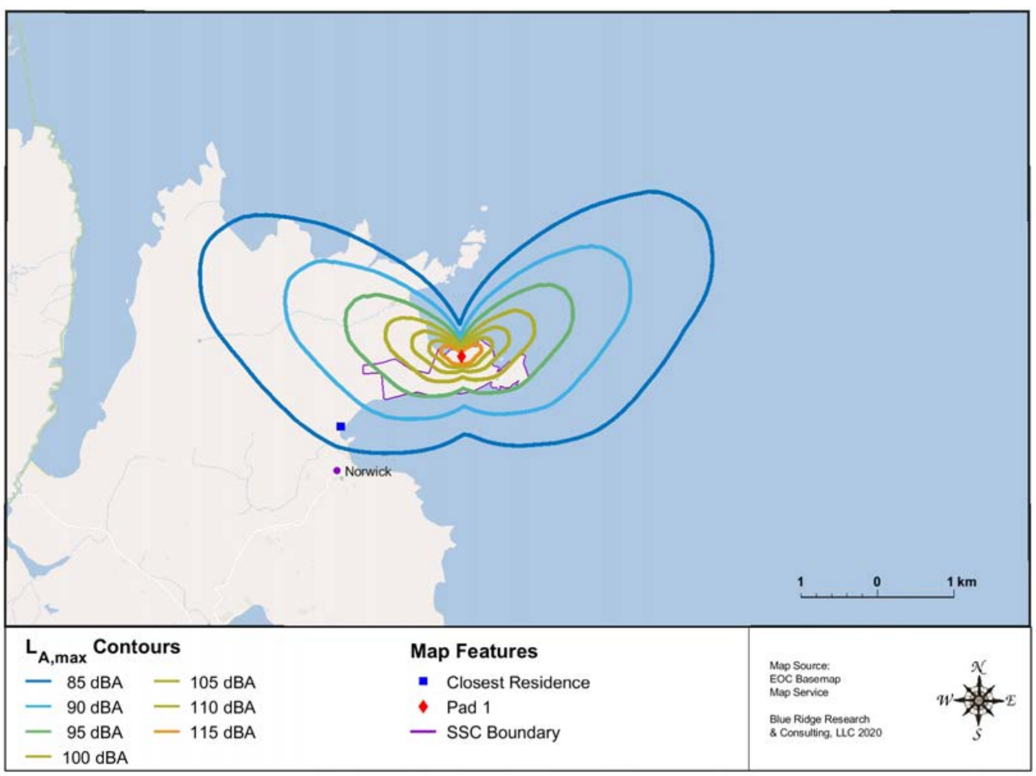

Figure 15. $L_{A,max}$ contours for a SCLV static fire from SSC Pad 1

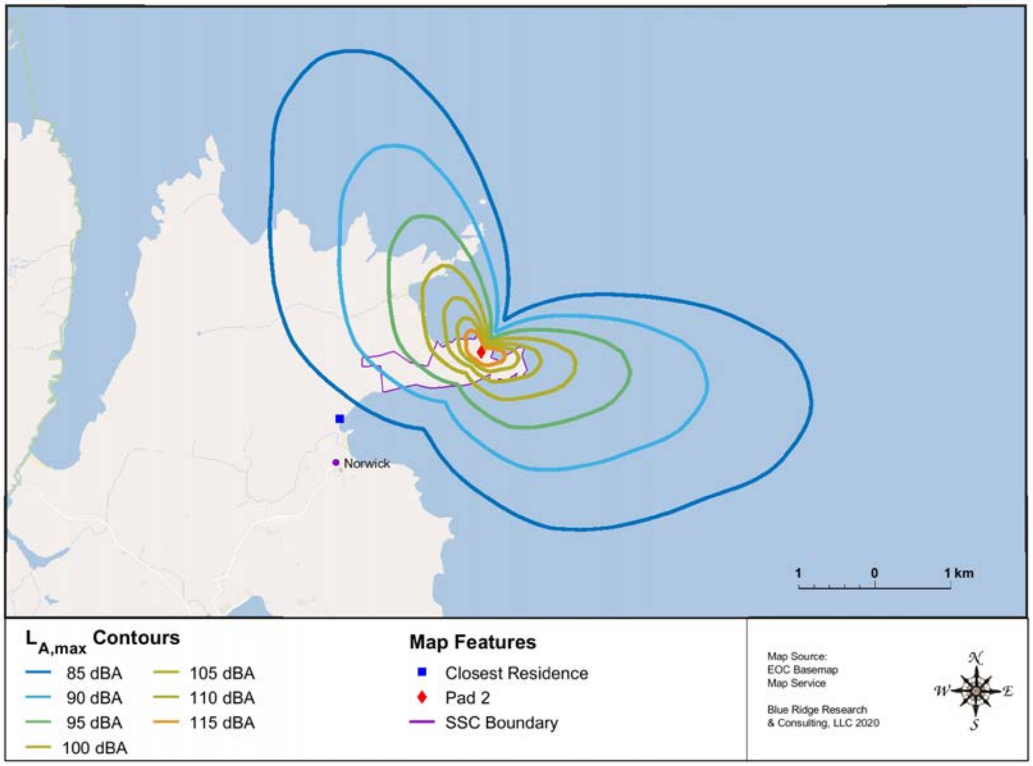

Figure 16. $L_{A,max}$ contours for a SCLV static fire from SSC Pad 2

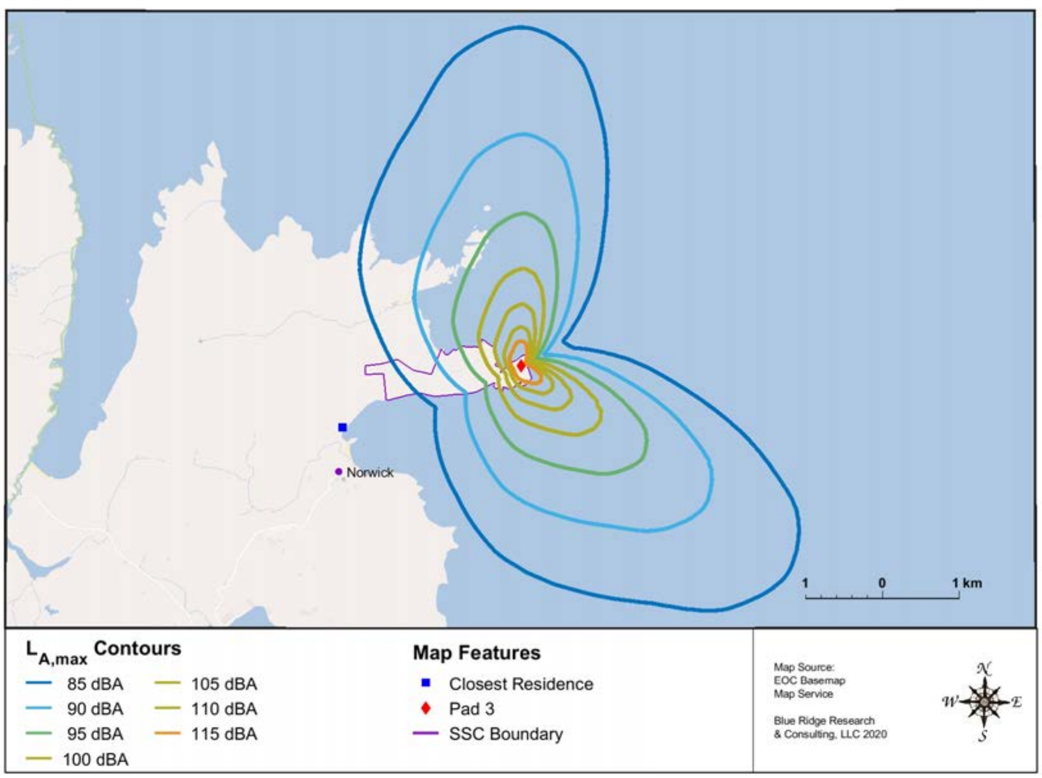

Figure 17. $L_{A,max}$ contours for a SCLV static fire from SSC Pad 3

5.1.2 Sound Exposure Level

The modeled ASEL contours associated with SCLV operations from SSC are presented in Figure 18 through Figure 23. Typically, ASEL levels in excess of 90 dBA indicate potential for sleep disturbance. Northern Unst is encompassed by the 90 dBA noise contours resulting from SCLV launch operations. Thus, the potential for sleep disturbance exists for nighttime launch operations.

Launch Operations – The 90 dBA contour for SCLV launch events from Pad 1, Pad 2, and Pad 3 are shown in Figure 18, Figure 19, and Figure 20, respectively. The SCLV launch event generates modeled levels at or above an ASEL of 90 dBA within 12.9 km of the pad nearest to the community.

Static Operations – The 90 dBA contour for SCLV static events at Pad 1, Pad 2, and Pad 3 are shown in Figure 21, Figure 22, and Figure 23, respectively. Note, the difference in zoom level between the launch and static operation results. The SCLV static event noise contours are more directive than the launch event noise contours because the plume is redirected in-line with the deflector heading for the entire duration of the event. A receptor located along the peak directivity angle may experience an ASEL of 90 dBA at approximately 4.2 km from the pad during a static event. Note, the levels produced by static events will remain constant over the duration of the event, whereas the levels produced by launch events will decrease as the rocket moves further away from the receptor.

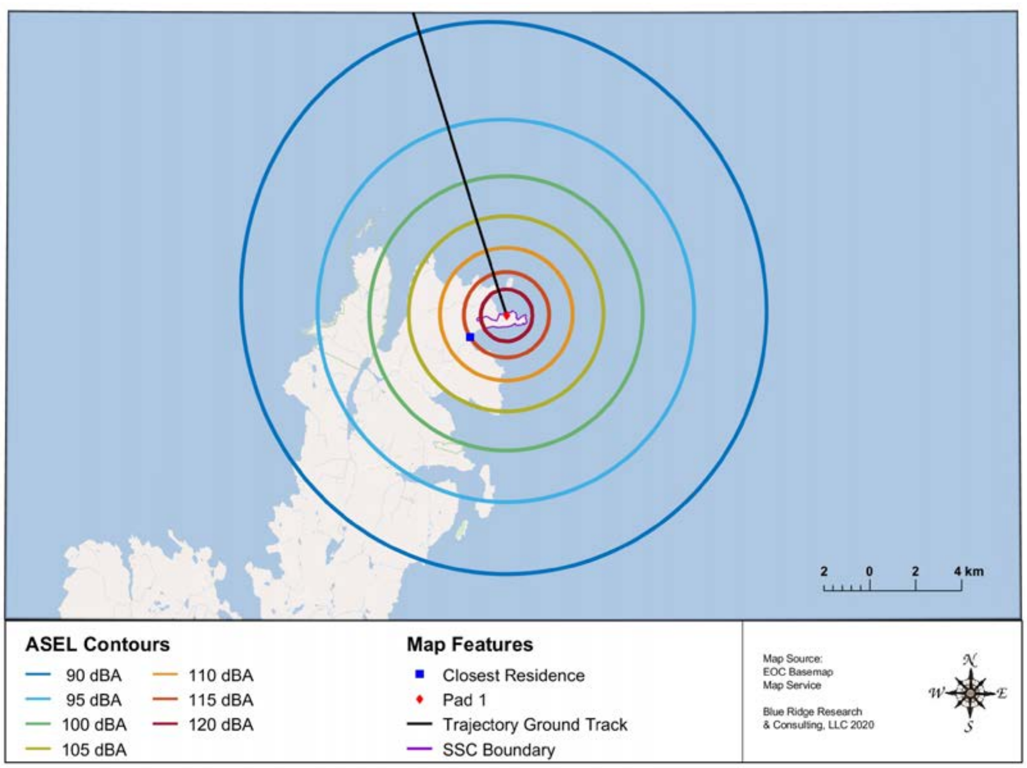

Figure 18. ASEL contours for a SCLV launch from SSC Pad 1

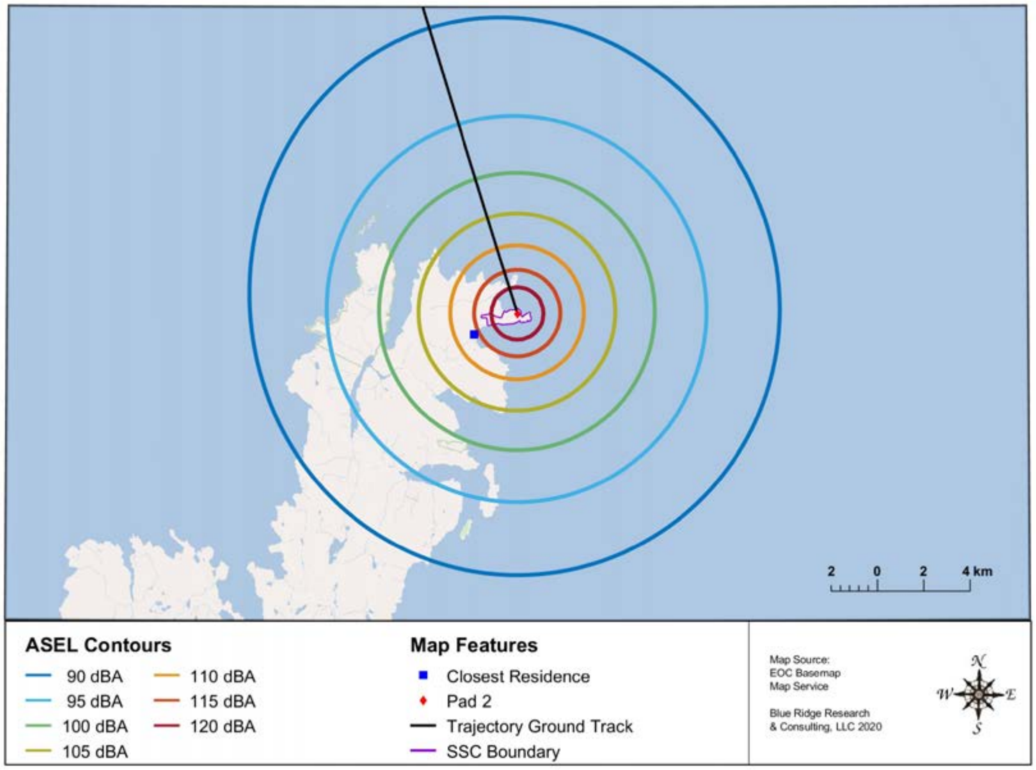

Figure 19. ASEL contours for a SCLV launch from SSC Pad 2

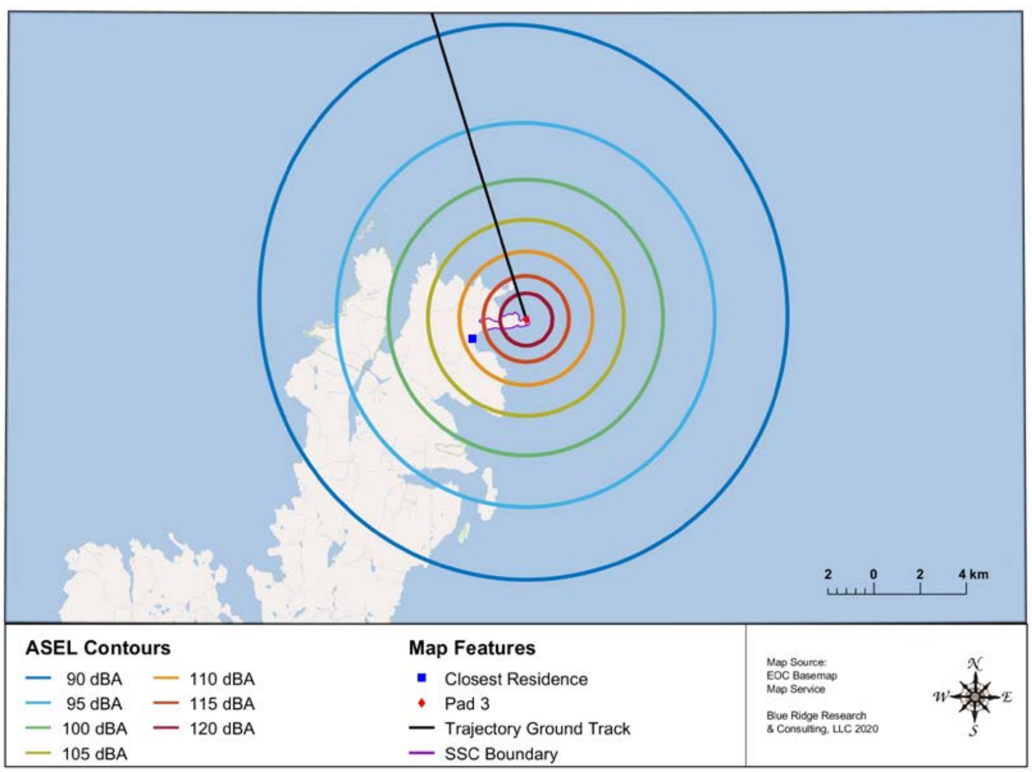

Figure 20. ASEL contours for a SCLV launch from SSC Pad 3

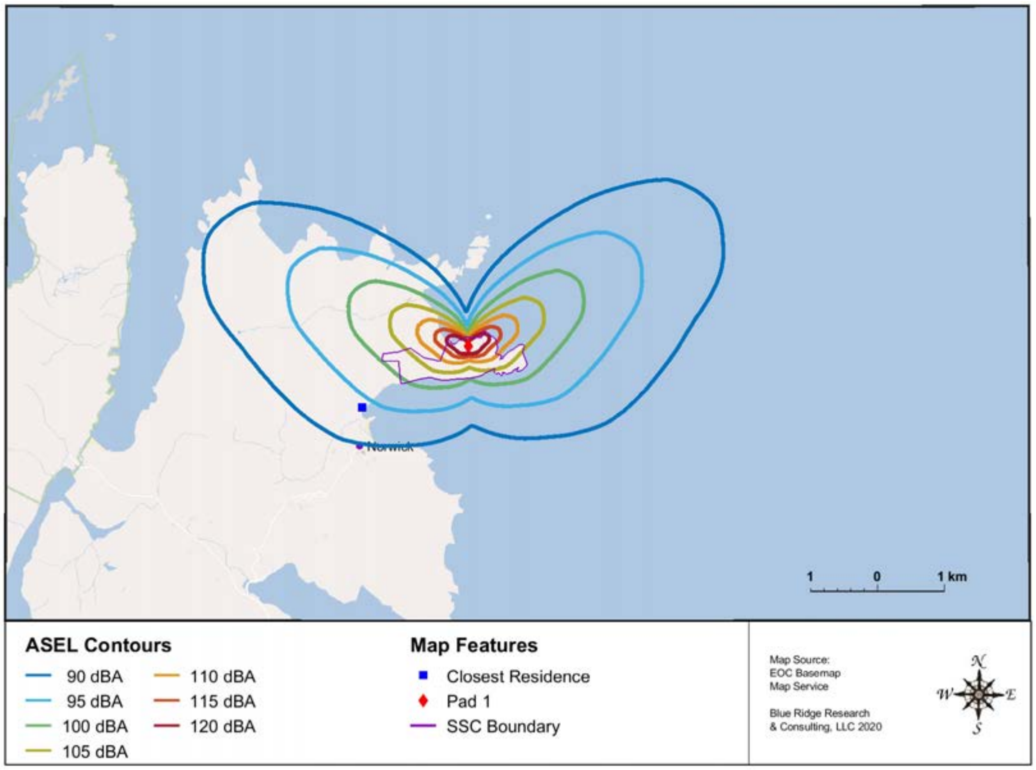

Figure 21. ASEL contours for a SCLV static fire from SSC Pad 1

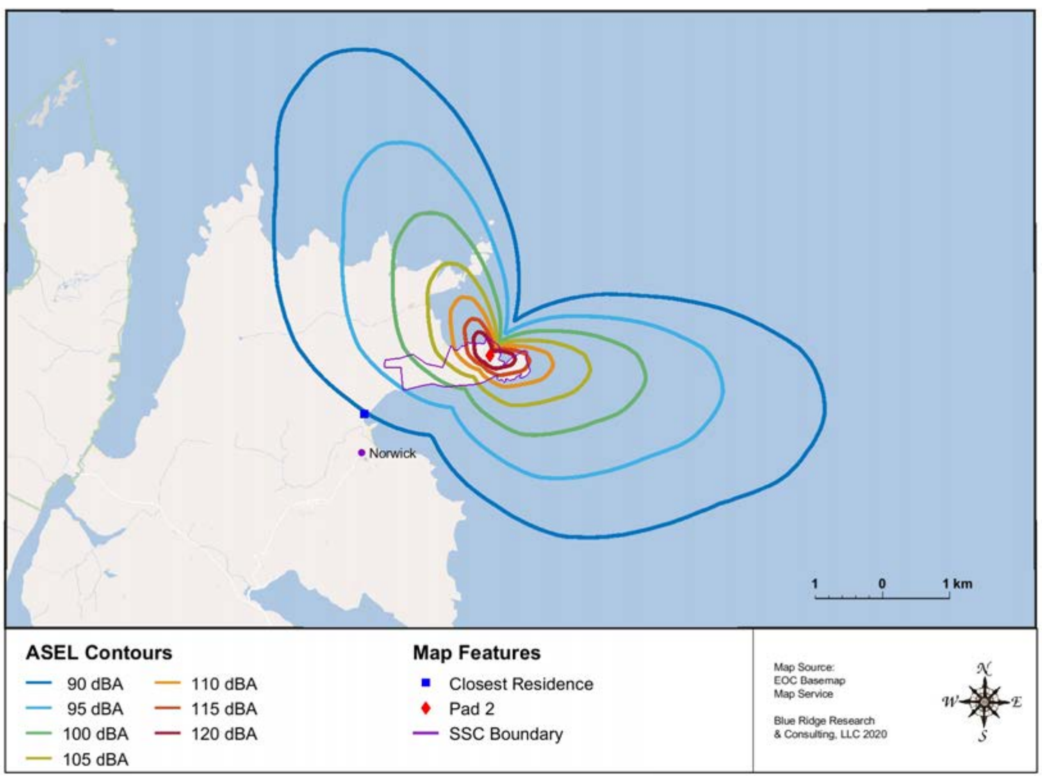

Figure 22. ASEL contours for a SCLV static fire from SSC Pad 2

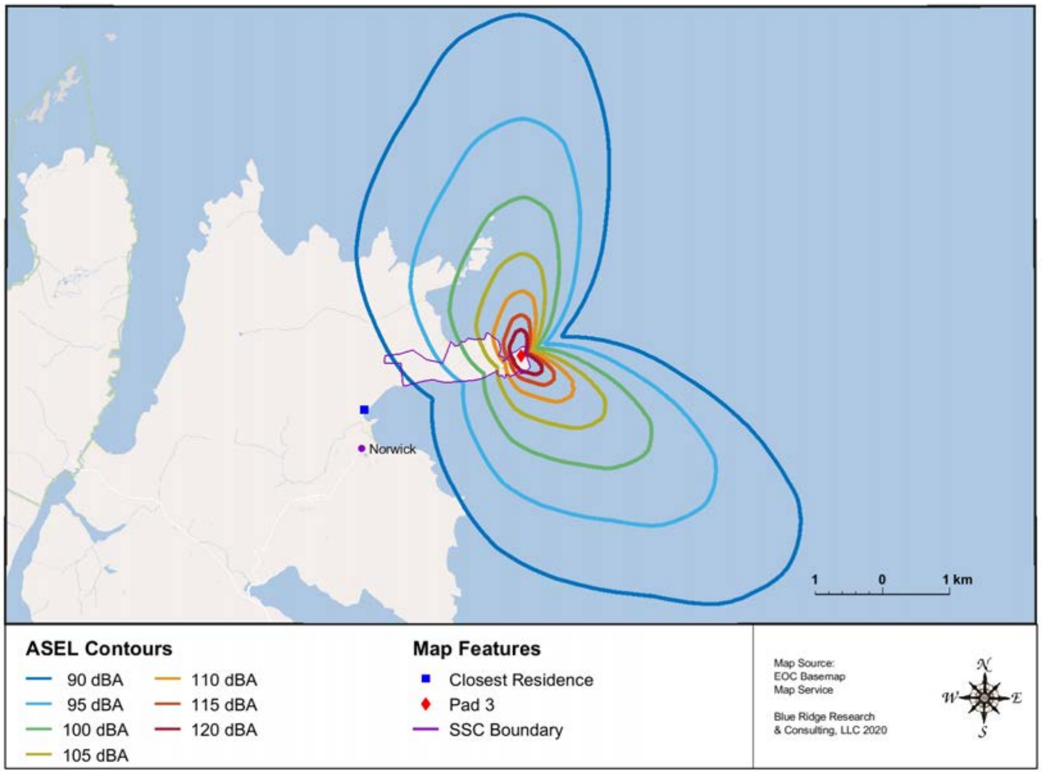

Figure 23. ASEL contours for a SCLV static fire from SSC Pad 3

5.1.3 Time Above

The modeled sound level time history for the event at the closest residence is shown in Figure 24. To provide additional context, Figure 24 displays the time above for four specified threshold levels which represent:

- A typical helicopter overflight (89 dBA);
- A speech intelligibility threshold of 95% (66 dBA);
- The average background noise level on Unst (45 dBA); and
- The background noise level on Unst that is exceeded 90% of the time (22 dBA).

To show the effect over the study region, the modeled time above contours associated with SCLV launch operations from SSC Pad 1, Pad 2, and Pad 3 are presented for 45 dBA, 66 dBA, and 89 dBA in Figure 25 to Figure 33. The shape of the contours depends on the selected time above threshold level. The TA45 contours, representing the time above the average background noise on Unst, increase from south to north over the study area and span a duration of 130-200 seconds. The TA66 contours, representing the time above the speech intelligibility threshold, shows a similar trend and span a duration of 60-95 seconds. The TA89 contours, representing the time above a typical helicopter overflight, generally decreases away from SSC and span a duration of 5-45 seconds.

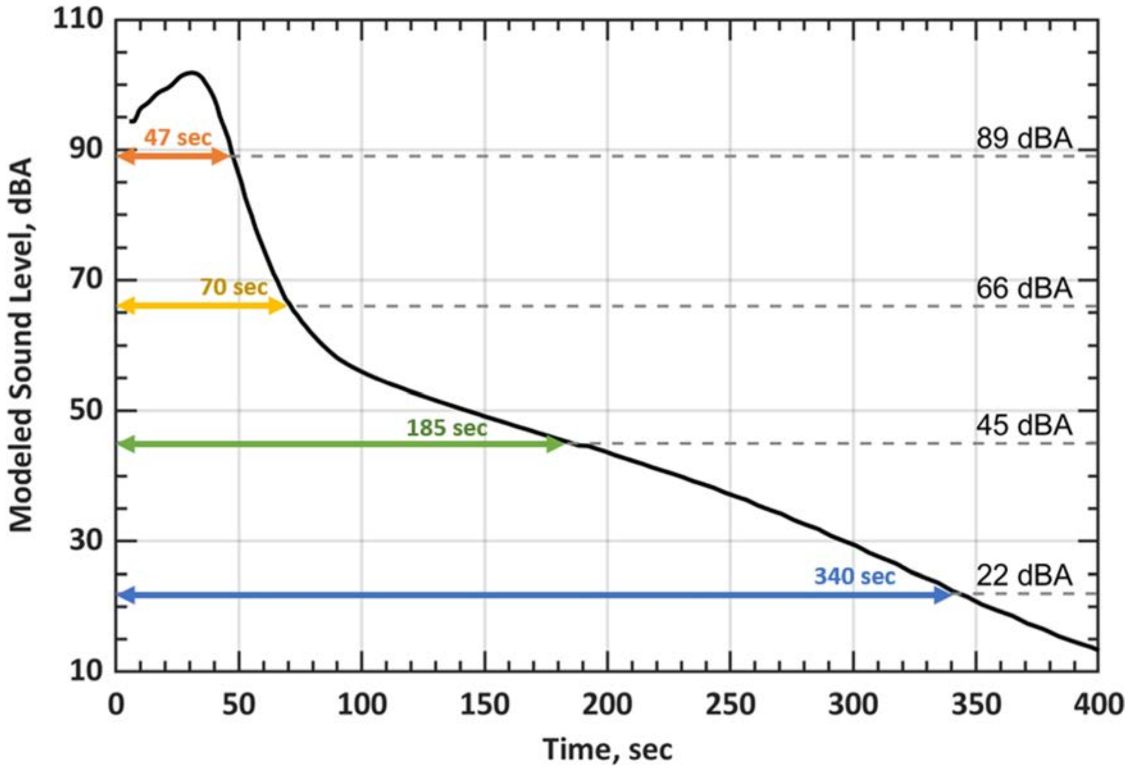

Figure 24. Modeled sound level time history at closest residence from SCLV launch operation.

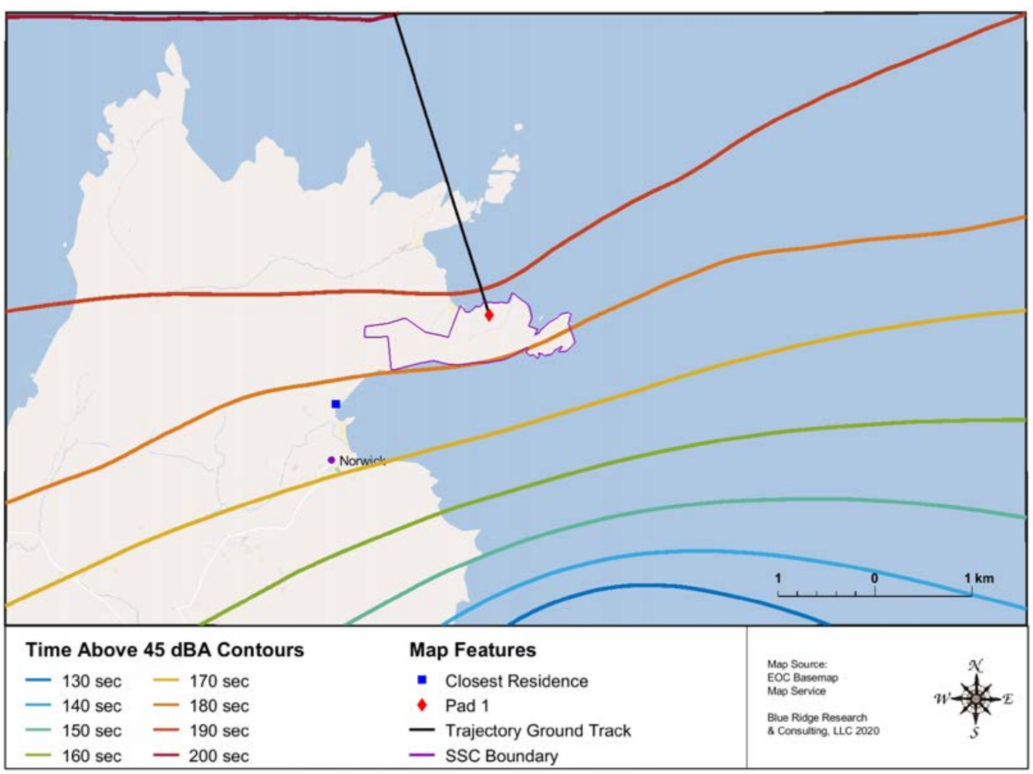

Figure 25. Time above 45 dBA contours for a SCLV launch from SSC Pad 1

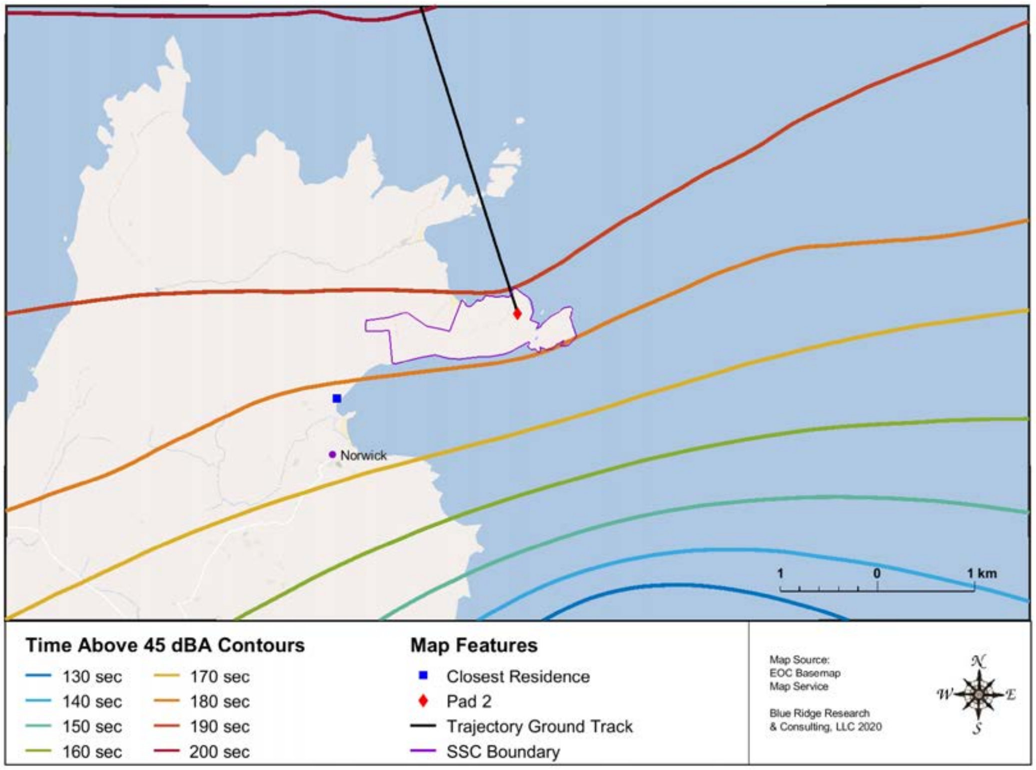

Figure 26. Time above 45 dBA contours for a SCLV launch from SSC Pad 2

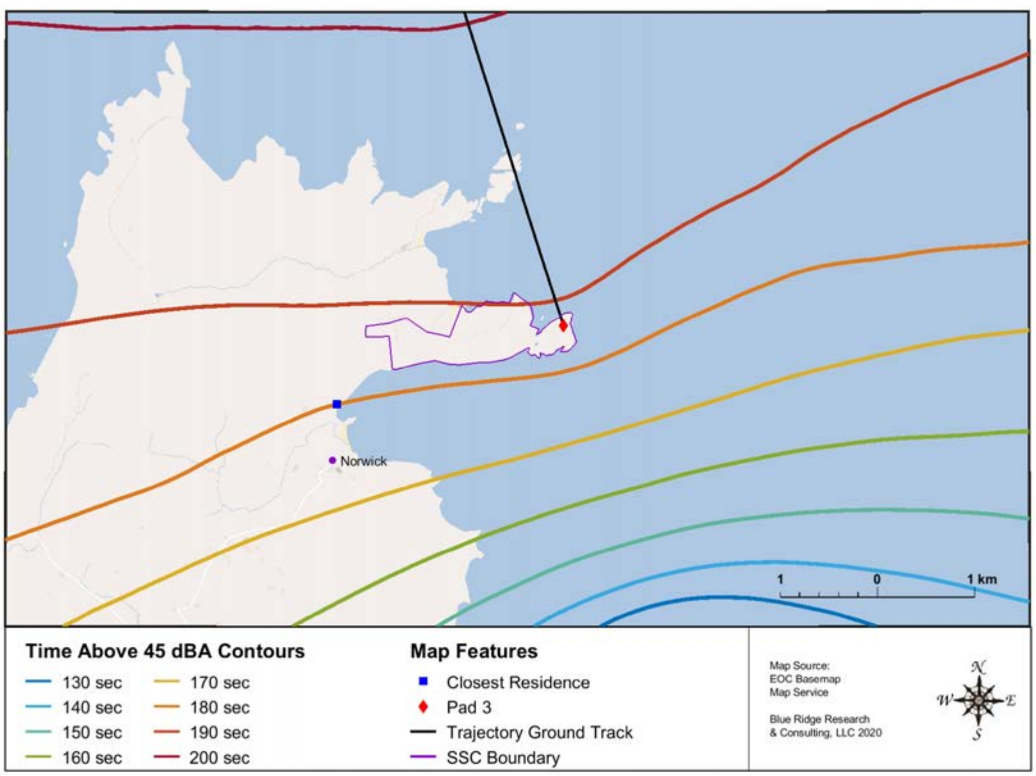

Figure 27. Time above 45 dBA contours for a SCLV launch from SSC Pad 3

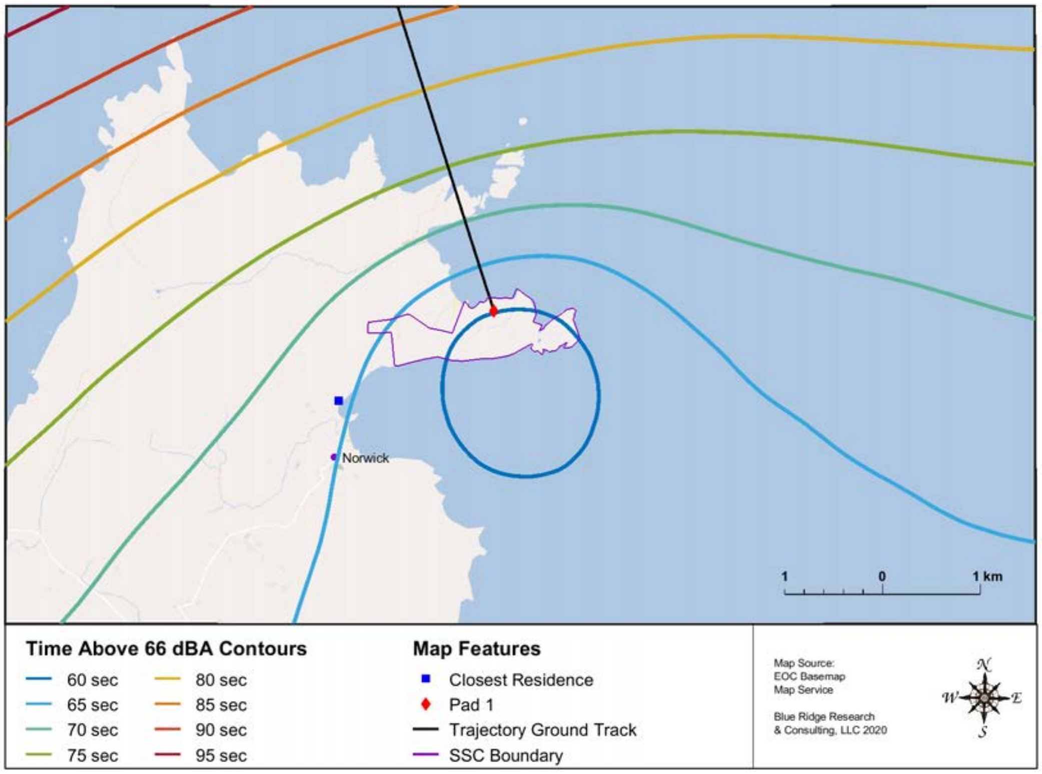

Figure 28. Time above 66 dBA contours for a SCLV launch from SSC Pad 1

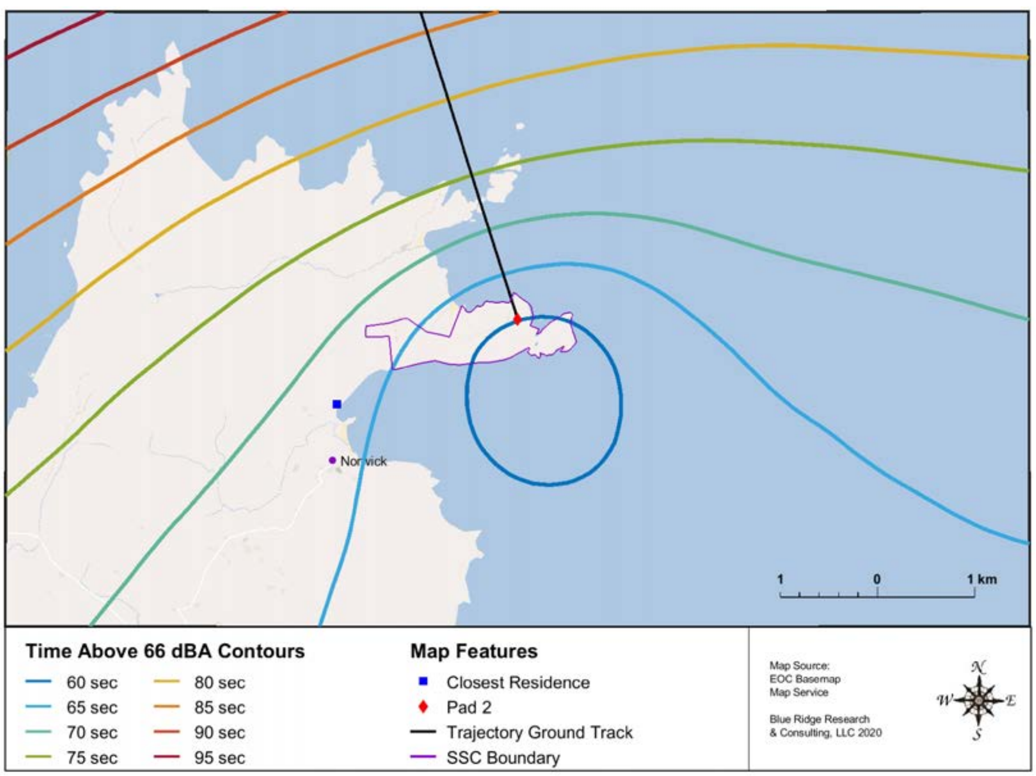

Figure 29. Time above 66 dBA contours for a SCLV launch from SSC Pad 2

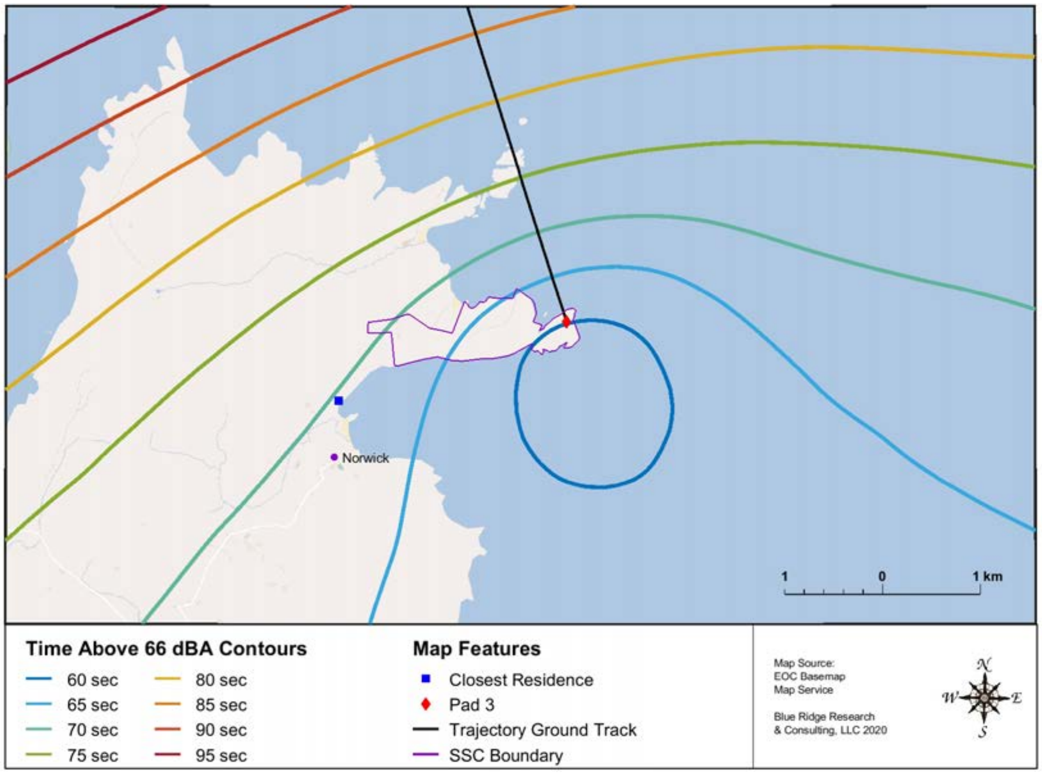

Figure 30. Time above 66 dBA contours for a SCLV launch from SSC Pad 3

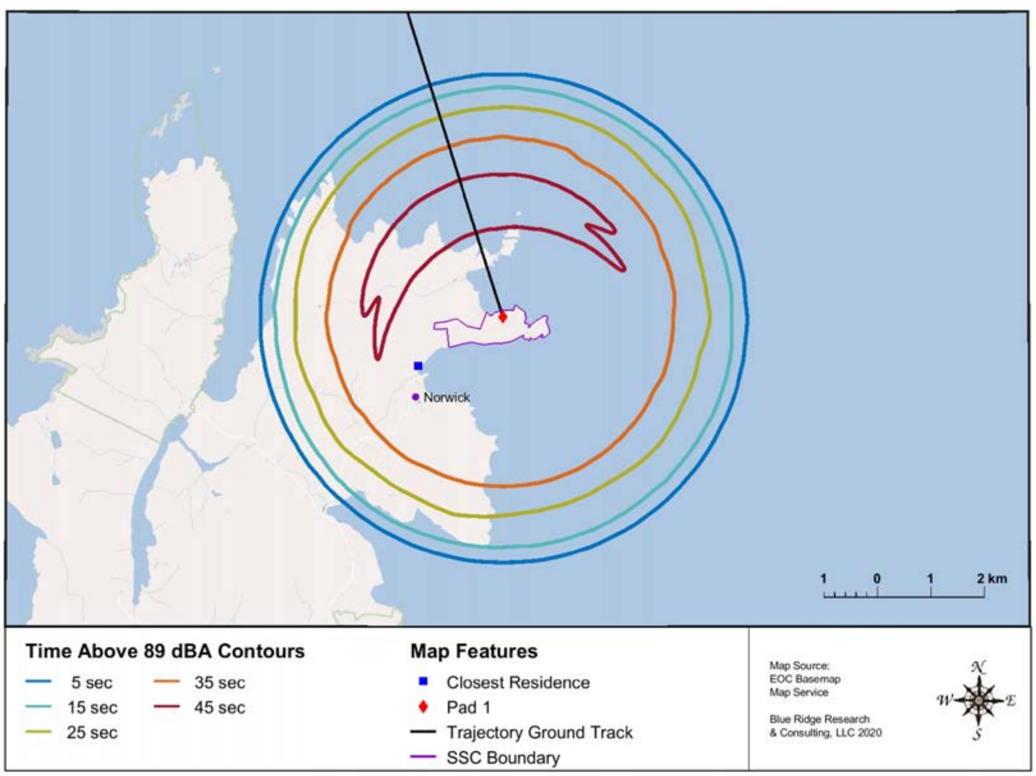

Figure 31. Time above 89 dBA contours for a SCLV launch from SSC Pad 1

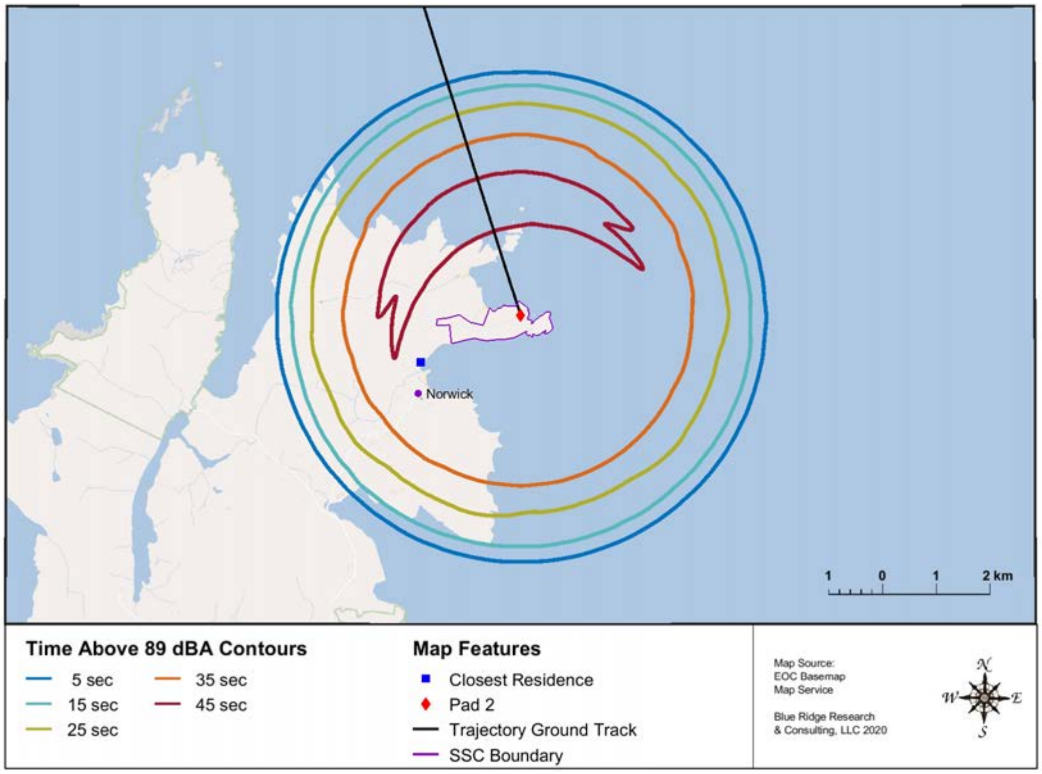

Figure 32. Time above 89 dBA contours for a SCLV launch from SSC Pad 2

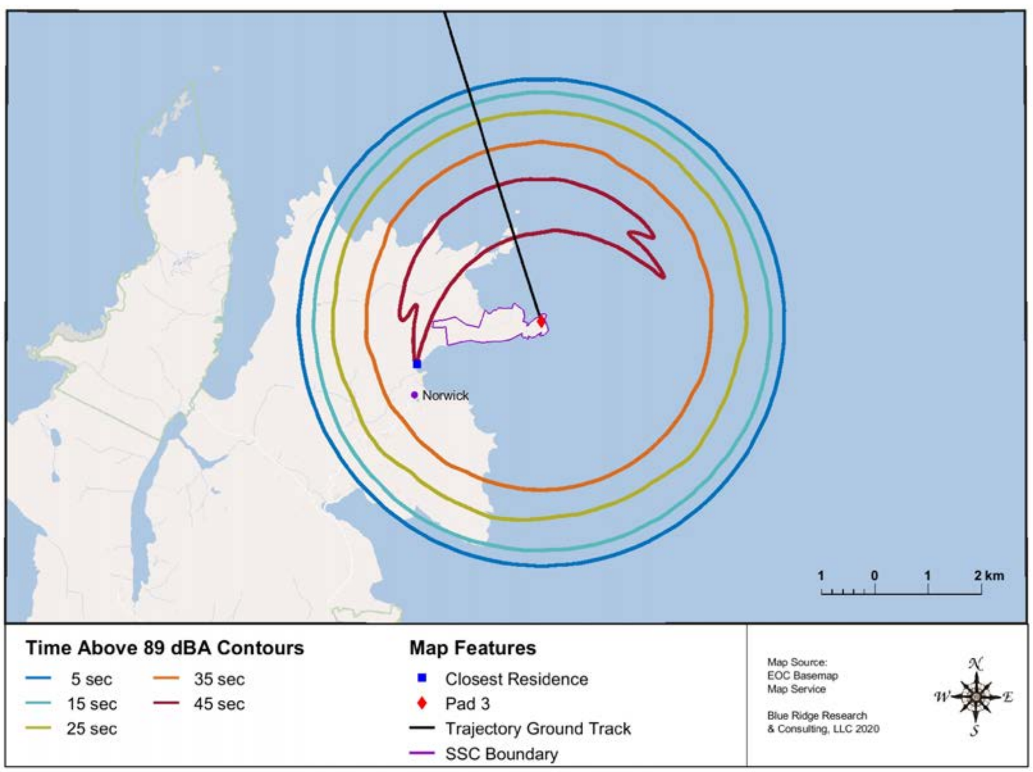

Figure 33. Time above 89 dBA contours for a SCLV launch from SSC Pad 3

5.1.4 Maximum Unweighted Sound Level (L_{max})

The modeled L_{max} contours associated with SCLV operations from SSC are presented in Figure 34 to Figure 39. For reference, the potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [23].

Launch Operations – The 120 dB and 111 dB contours for SCLV launch events from Pad 1, Pad 2, and Pad 3 are shown in Figure 34, Figure 32, and Figure 36, respectively. The modeled 120 dB and 111 dB contours are limited to radii of 1.0 km and 2.5 km from the pad nearest the community, respectively. The closest residence and Norwick lie outside the 120 dB contour, but within the 111 dB contour.

Static Operations – The 120 dB and 111 dB contour for SCLV static events at Pad 1, Pad 2, and Pad 3 are shown in Figure 37, Figure 38, and Figure 39, respectively. For a SCLV static event, a receptor located along the peak directivity angle may experience L_{max} values of 120 dB and 111 dB at approximately 1.0 km and 2.4 km from the pad nearest the community, respectively.

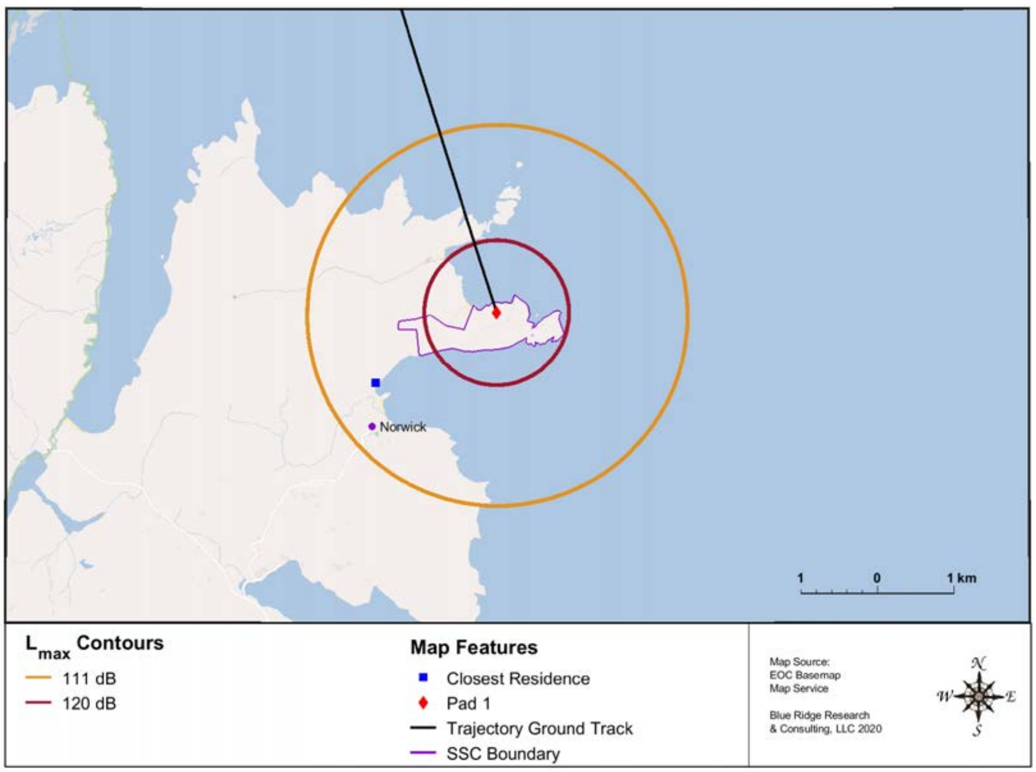

Figure 34. L_{max} contours for a SCLV launch from SSC Pad 1

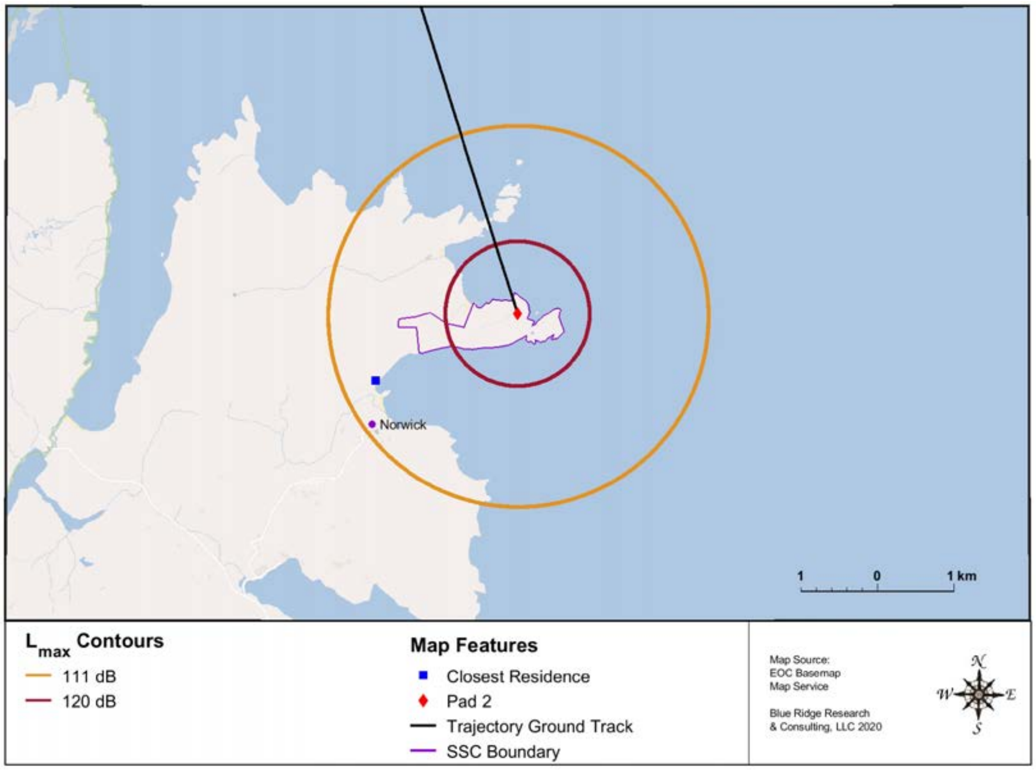

Figure 35. L_{max} contours for a SCLV launch from SSC Pad 2

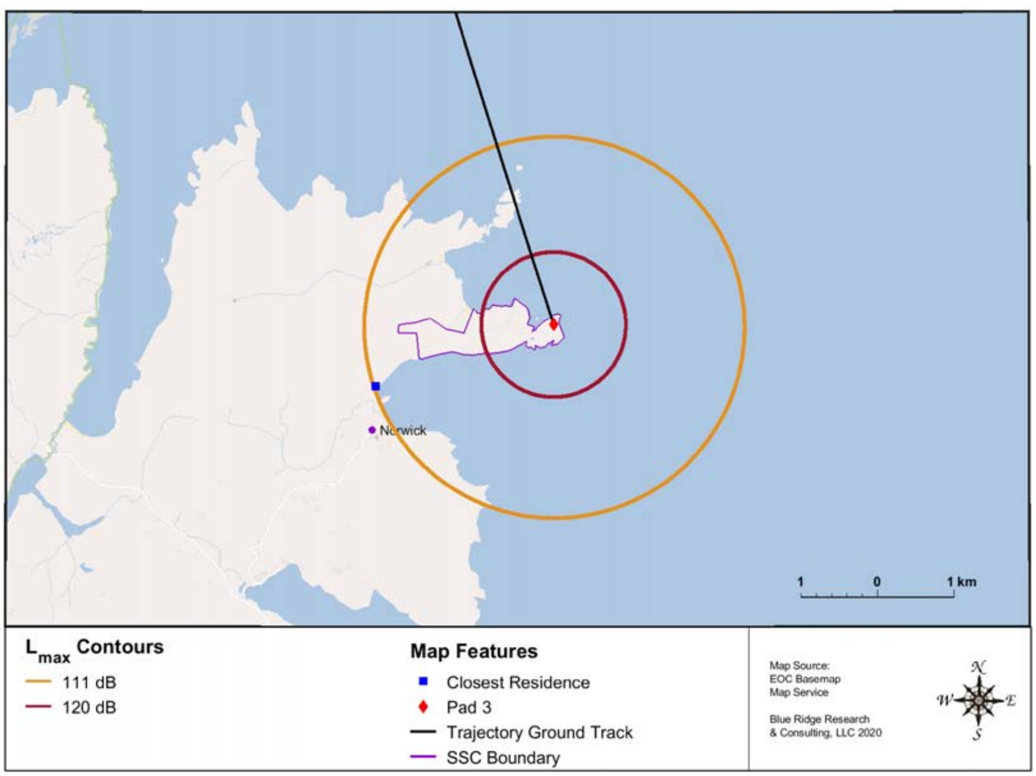

Figure 36. L_{max} contours for a SCLV launch from SSC Pad 3

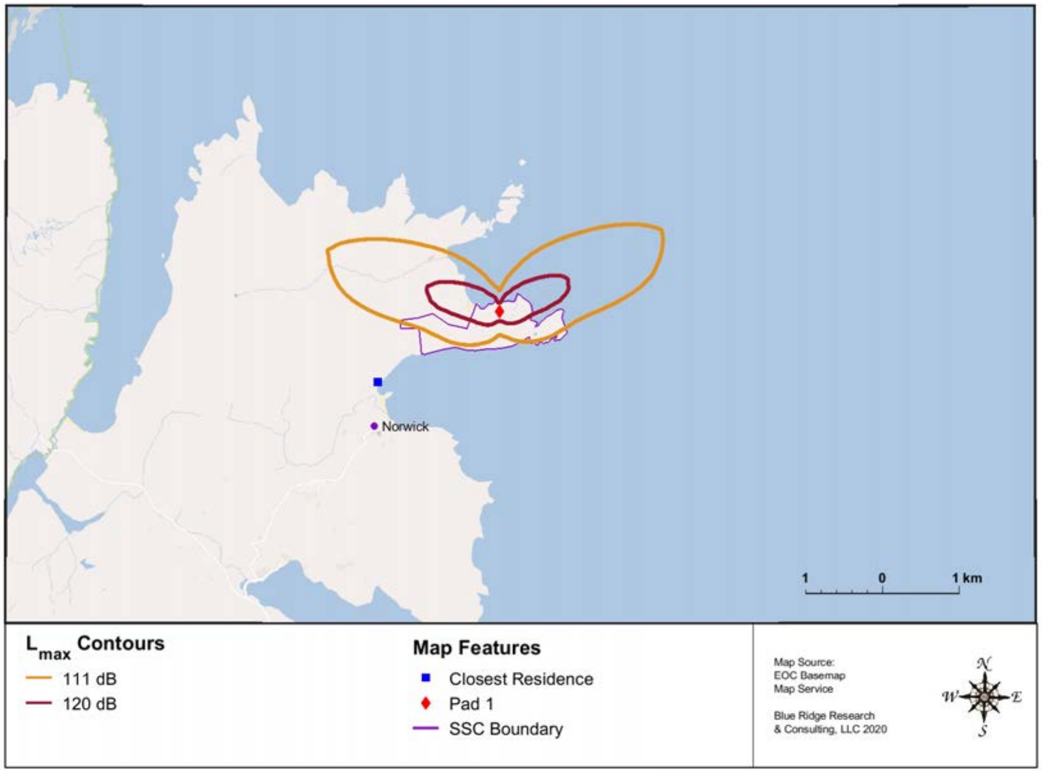

Figure 37. L_{max} contours for a SCLV static fire from SSC Pad 1

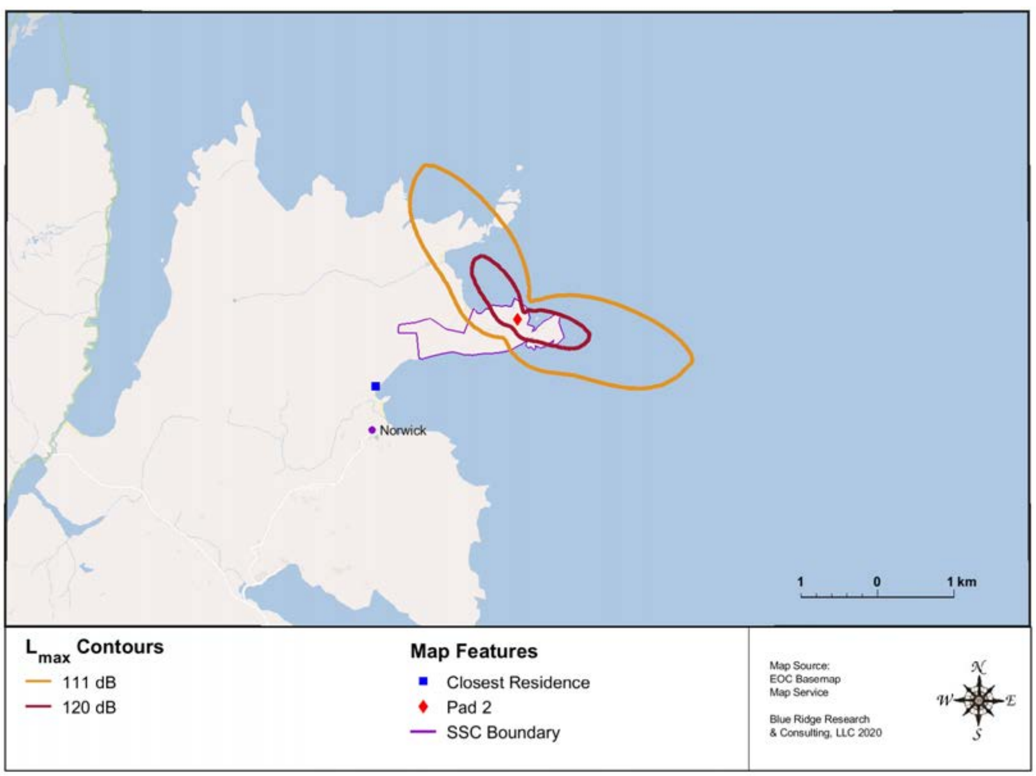

Figure 38. L_{max} contours for a SCLV static fire from SSC Pad 2

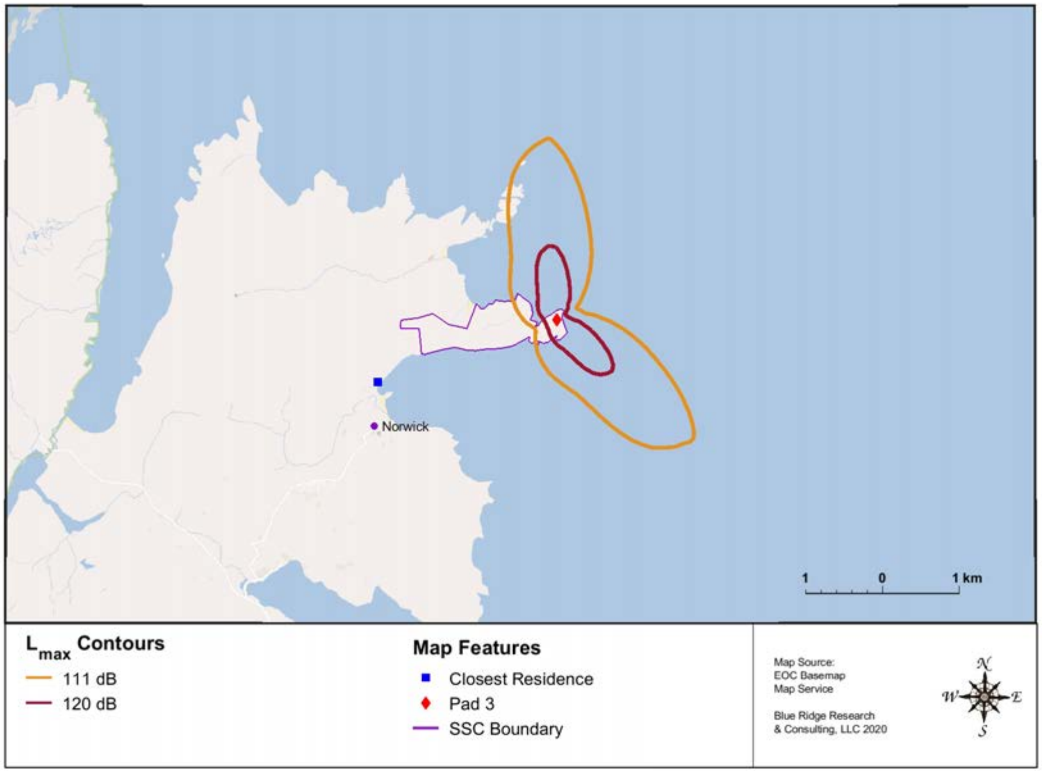

Figure 39. L_{max} contours for a SCLV static fire from SSC Pad 3

5.2 Single Event Sonic Boom Metrics and Effects

Individual launch site operations are evaluated using peak overpressure for sonic booms. To evaluate the sonic boom impacts from SSC operations, the nominal trajectory from the center launch site (Pad 2) was modeled. The resulting sonic boom footprint spans a much larger geographic area relative to the distance between adjacent pads, thus the results from Pad 1 and Pad 3 will produce similar levels with minor deviations to the precise location.

The sonic boom peak overpressure contours for the modeled SCLV launch operations are presented in Figure 40. The sonic boom footprint produced by the SCLV launch vehicle has a long, narrow, forward-facing, crescent-shaped focus boom region beginning 60 km downrange of the launch site. The focus boom region is generated because the launch vehicle continuously accelerates and pitches downward as it ascends. The maximum peak overpressure along the focus boom region is predicted to be approximately 5.4 psf. However, these high levels would only occur in extremely small areas along the focus boom region. As the rocket gains altitude, the sonic boom peak overpressure gradually decreases, and the crescent-shaped contours become slightly wider.

The sonic booms were modeled based on a single launch trajectory at a nominal azimuth of 343° relative to true north. The sonic boom peak overpressure contours for the modeled SCLV launch operation are predicted to be entirely over water. Thus, the potential for structural damage and hearing damage (with regards to humans) is not expected. The exact location of the sonic boom footprint produced by each SCLV launch operation will be highly dependent on the vehicle configuration, trajectory, and atmospheric conditions at the time of flight.

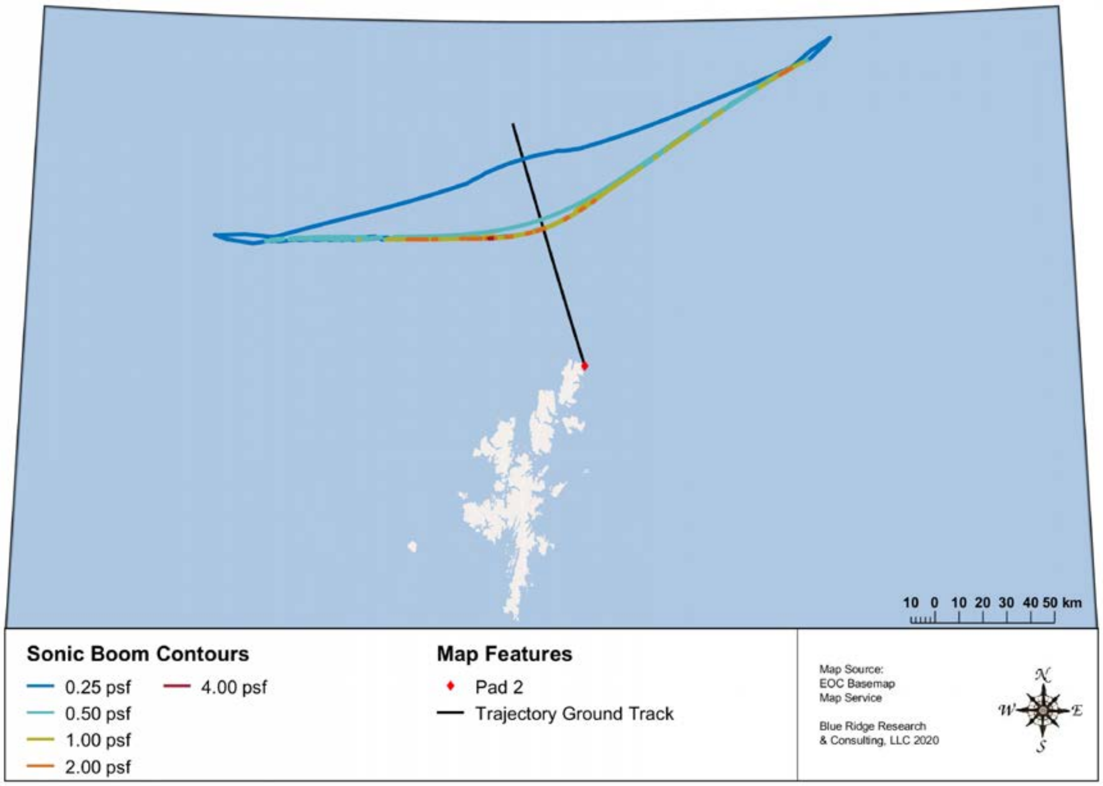

Figure 40. Sonic boom peak overpressure contours for a SCLV launch from SSC

5.3 Cumulative Noise Metrics

The potential for long-term community annoyance is assessed using A-weighted L_{den} for launch vehicle noise and C-weighted L_{den} for sonic booms.

Launch Site Operations

To assess cumulative noise impacts, a criteria of 55 dBA is used by the UK government. The L_{den} contours for all SSC launch and static operations are presented in Figure 41. The L_{den} 55 dBA contours extend approximately 3.3 km from the launch pad nearest the community. This area encompasses the closest residence, which is modeled to receive 59 dBA. Norwick is also encompassed by the 55 dBA contour.

The sonic booms resulting from the modeled launch trajectory occur entirely over the Atlantic Ocean. Therefore, with respect to human annoyance, noise impacts due to sonic booms for the launch trajectory are not expected. Thus, a quantitative L_{den} analysis was not performed.

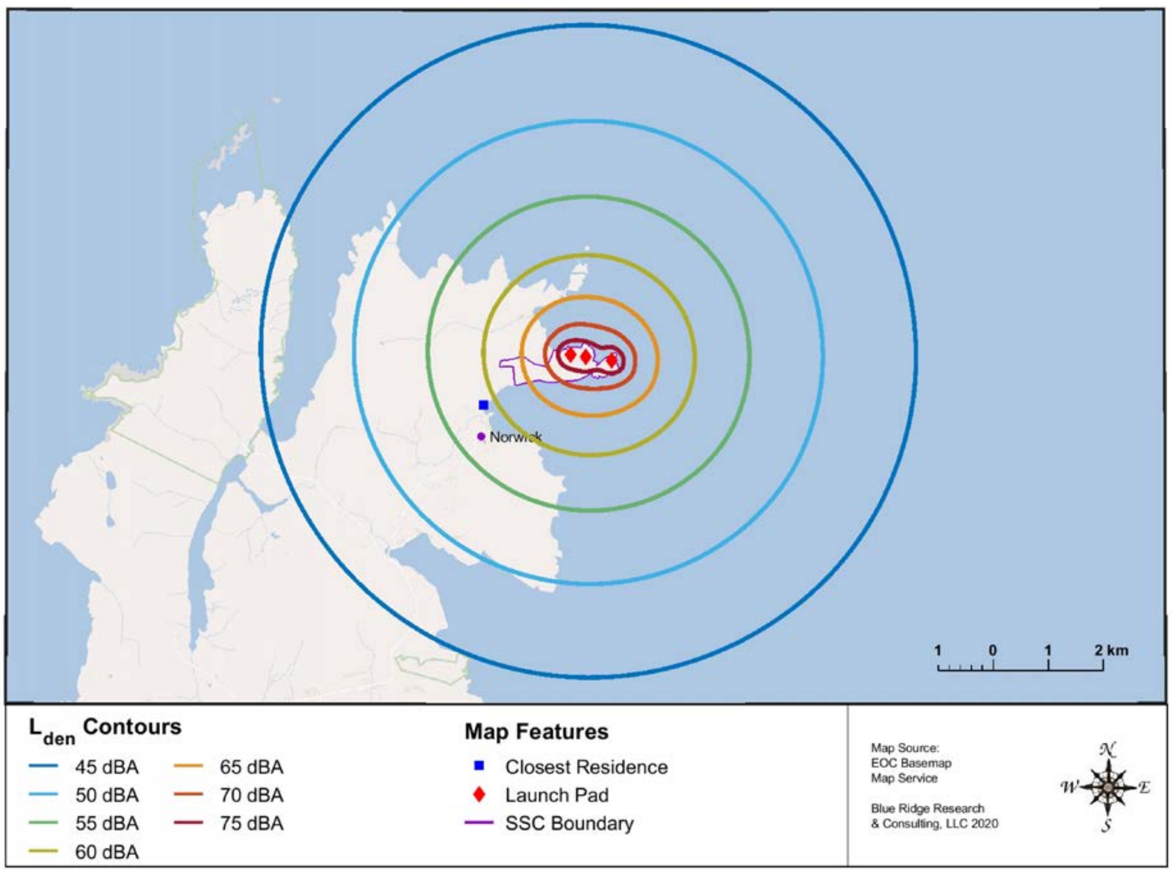

Figure 41. L_{den} contours for SCLV launch and static operations from all pads at SSC

6 Summary

This report documents the noise study performed as part of SSC's efforts on the EIA for the proposed SCLV operations. SSC plans to conduct launch and static operations of SCLV launch vehicles from three pads. The potential impacts of launch vehicle noise and sonic booms are evaluated on a cumulative basis in terms of human annoyance. In addition, potential impacts are evaluated on a single-event basis in relation to hearing conservation, sleep disturbance, speech interference, and structural damage.

Single Event Noise Results with respect to Hearing Conservation

An upper limit noise level of $L_{A,max}$ 115 dBA is used as a guideline to protect human hearing from long-term continuous daily exposures to high noise levels and to aid in the prevention of NIHL. There are no residences within the land area encompassed by the 115 dBA noise contours resulting from SCLV operations.

For impulsive noise events such as sonic booms, the potential for impacts to people in the community with regards to hearing conservation is not expected as the modeled sonic boom footprint is entirely over water.

Single Event Noise Results with respect to Sleep Disturbance

Studies have found that ASEL above 90 dBA generally leads to sleep disturbance. Northern Unst is encompassed by the 90 dBA noise contours resulting from SCLV launch operations. Thus, the potential for sleep disturbance exists for nighttime launch operations.

Single Event Noise Results with respect to Structural Damage

The potential for structural damage claims is approximately one damage claim per 100 households exposed at 120 dB and one in 1,000 households at 111 dB [23]. While there are no residences within the land area encompassed by the 120 dB noise contours resulting from SCLV operations, the closest residence and Norwick lie between the 120 dB and 111 dB contours.

For impulsive noise events such as sonic booms, noise impacts to structures are not expected as the modeled sonic boom footprint is entirely over water. Thus, the potential for structural damage is negligible.

Cumulative Noise Results

The L_{den} 55 dBA contour is used to identify the potential for significant noise impacts resulting from the propulsion noise generated by SCLV operations. The area identified within the 55 dBA contour for cumulative noise impacts includes the closest residence and Norwick.

For impulsive noise events such as sonic booms, cumulative noise impacts with respect to human annoyance are not expected as the modeled sonic boom footprint is entirely over water.

7 References

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Appendix 8.2 Summaries of Guidance

PAN1/2011

PAN1/2011 (Scottish Government, 2011), sets out a series of noise issues for planning authorities to consider when making decisions on planning applications. A Technical Advice Note (TAN) on Assessment of Noise (Scottish Government, 2011) has been published to accompany PAN 1/2011. In Appendix 1 of the TAN are codes of practice for the assessment of various sources of noise. It also identifies British Standard BS 5228 for guidance on construction site noise control, and as a method of prediction of noise from construction sites.

The TAN recommends that the daytime period includes the hours 07:00 – 23:00 and the night-time period 23:00 – 07:00.

The TAN suggests that equivalent continuous noise level over a time period, T ($L_{Aeq,T}$), is a good general purpose index for environmental noise; this index is commonly referred to as the "ambient" noise level. It further notes that road traffic noise is commonly evaluated using the $_{LA10,18hr}$ level, and the $L_{A90,T}$ index is used to describe the "background" noise level.

Table 2.4 of the TAN (reproduced here as Table 1) provides an example method for determining the magnitude of noise impacts at proposed noise sensitive developments.

Table 1 - PAN1/2011 TAN Example of associating changes in noise levels with magnitudes of impacts for a new road in a residential area

(existing – target) Noise level, x dB $L_{A10,18hr}$ (07:00 – 23:00)	Magnitude of impact
x = 5	Major adverse
3 = x < 5	Moderate adverse
1 = x < 3	Minor adverse
0 < x < 1	Negligible adverse
x = 0	No change

Table 2.6 of the TAN (reproduced here as Table 2) provides a matrix for determining the level of impact significance dependent on the sensitivity of the receptor.

Table 2 - PAN1/2011 TAN Significance of effects

Magnitude of impact	Level of significance relative to sensitivity of receptor		
	Low	Medium	High
Major	Slight/Moderate	Moderate/Large	Large/Very Large
Moderate	Slight	Moderate	Moderate/Large
Minor	Neutral/Slight	Slight	Slight/Moderate
Negligible	Neutral/Slight	Neutral/Slight	Slight
No change	Neutral	Neutral	Neutral

Table 2.1 of the TAN (reproduced below as Table 3) provides the criteria to define levels of sensitivity for each type of NSR.

Table 3 - PAN1/2011 TAN Level of Noise Sensitivity for Different Types of NSR

Sensitivity	Description	Example of NSR
High	Receptors where people or operations are particularly susceptible to noise	• Residential, including private gardens where appropriate • Quiet outdoor areas used for recreation • Conference facilities • Theatres/Auditoria/Studios • Schools during the daytime • Hospitals/residential care homes • Places of worship
Medium	Receptors moderately sensitive to noise, where it may cause some distraction or disturbance	• Offices • Bars/Cafes/Restaurants where external noise may be intrusive • Sports grounds when spectator noise is not a normal partof the event and where quiet conditions are necessary (e.g. tennis, golf, bowls)
Low	Receptors where distraction or disturbance from noise is minimal	• Buildings not occupied during working hours • Factories and working environments with existing high noise levels • Sports grounds when spectator noise is a normal part for the event • Night clubs

BS4142:2014+A1:2019 - Methods for Rating and Assessing Industrial and Commercial Sound

BS 4142 (BSI, 2014) describes methods for rating and assessing sound[1] from industrial or commercial premises. The methods detailed in BS4142 use outdoor sound levels to assess the likely effects on people inside or outside a residential dwelling upon which sound is incident.

The Standard provides methods for determining the following:

- Rating levels for sources of industrial and commercial sound; and
- Ambient, background and residual sound levels.

These may be used for assessing sound from proposed, new, modified or additional sources of sound of a commercial or industrial nature.

The Standard makes use of the following terms:

- **Ambient sound level, $L_a = L_{Aeq,T}$** – the equivalent continuous sound pressure level of the totally encompassing sound in a given situation at a given time, usually from multiple sources, at the assessment location over a given time interval, T;
- **Background sound level, $L_{A90,T}$** – the A-weighted sound pressure level that is exceeded by the residual sound at the assessment location for 90 percent of a given time interval, T, measured using time weighting F and quoted to the nearest whole number of decibels;
- **Specific sound level, $L_s = L_{Aeq,T}$** – the equivalent continuous sound pressure level produced by the specific sound source at the assessment location over a given reference time interval, T;
- **Rating level, $L_{Ar,Tr}$** – the specific sound level plus any adjustment for the characteristic features of the sound; and
- **Residual sound level, $L_{r = LAeq,T}$** – the equivalent continuous sound pressure level at the assessment location when the specific sound source is suppressed to such a degree that it does not contribute to the ambient sound, over a given reference time interval, T.

The Standard determines the degree of noise impact by comparison of the background noise level at noise sensitive receptors (NSR) in the absence of the industrial facility (the specific source) with the ambient sound level when the specific source is operational.

Where particular characteristics, such as tonality, intermittency or impulsivity are present in the noise emissions of the specific source, the Standard requires that "penalties" be added to the specific sound level to derive the rating level, to account for the increased annoyance that these can cause. Where no such characteristics are present, or where they are

[1] The Standard refers to sound levels, rather than noise levels, however, these terms can be used interchangeably, as noise is defined as "unwanted sound". This assessment uses the term "noise".

inaudible at the receptor locations then no penalties apply and the rating level is the same as the specific level.

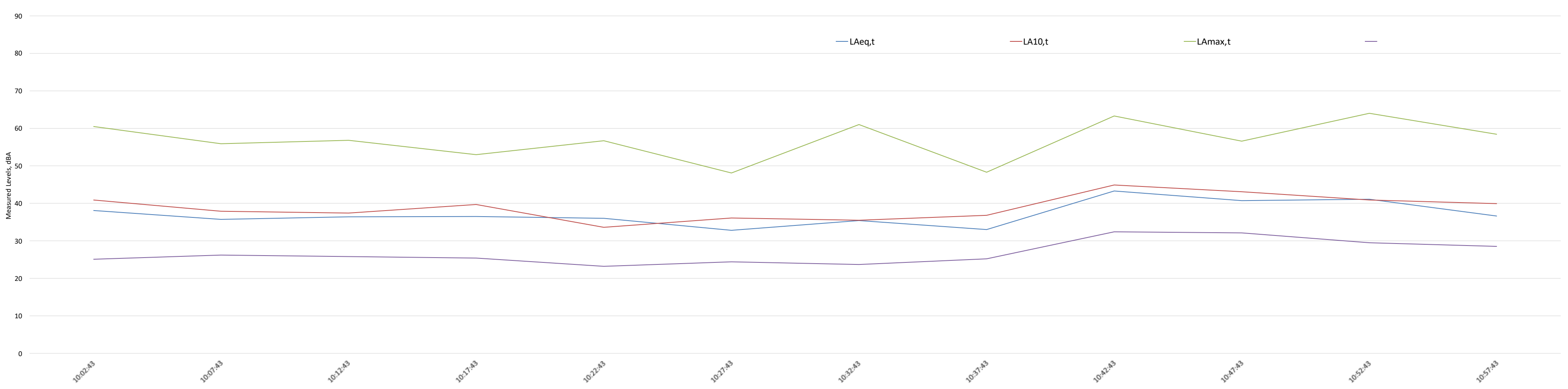
The following impact significance identifiers are provided in the Standard, in which the difference between the specific sound level and measured background level are considered:

- The greater the difference, the greater the magnitude of impact;
- A difference of around +10 dB or more is likely to be an indication of a significant adverse impact;
- A difference of around +5 dB is likely to be an indication of an adverse impact;
- The lower the rating level, relative to the measured background level, the less likely that the specific sound source will have an adverse (or significant adverse) impact; and
- Where the rating level does not exceed the background sound level, this is an indication of the specific sound source having a low impact.

Appendix 8.3 Summary of Baseline Survey

NMP1 - Unst Airport - Day

NMP Description	Open fields on access track to Unst airfield. Scattered dwellings along road to north, with Balta Sound inlet to the north
Weather Conditions	Dry, 15°C, overcast, low - moderate wind speed (<5 m/s)
Coordinates	HP624478,08115
File #	
Main Noise Sources	Bird calls, bleating sheep
Secondary Noise Sources	Very infrequent vehicle movements on loacl roads (8 movements during measurement), children playing at nearby house
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.

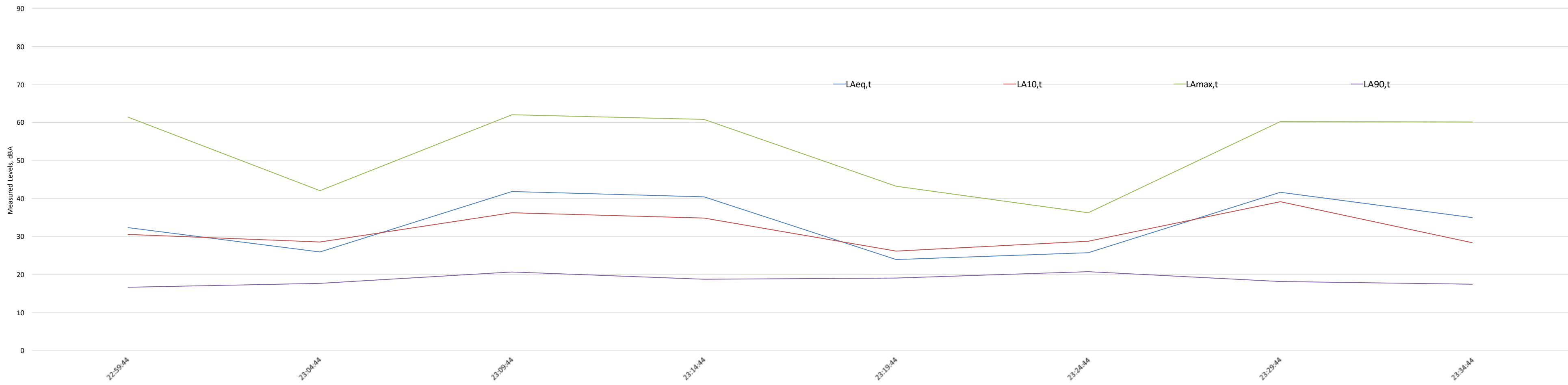


Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	10:02:43	00d 00:05:00.0	38.1	60.5	40.9	25.1	
19/07/2018	10:07:43	00d 00:05:00.0	35.7	55.9	37.9	26.2	
19/07/2018	10:12:43	00d 00:05:00.0	36.4	56.8	37.4	25.8	
19/07/2018	10:17:43	00d 00:05:00.0	36.5	53.0	39.7	25.4	
19/07/2018	10:22:43	00d 00:05:00.0	36.0	56.7	33.6	23.2	
19/07/2018	10:27:43	00d 00:05:00.0	32.8	48.1	36.1	24.4	
19/07/2018	10:32:43	00d 00:05:00.0	35.4	61.0	35.5	23.7	
19/07/2018	10:37:43	00d 00:05:00.0	33.0	48.3	36.8	25.2	
19/07/2018	10:42:43	00d 00:05:00.0	43.3	63.3	44.9	32.4	
19/07/2018	10:47:43	00d 00:05:00.0	40.7	56.6	43.1	32.1	
19/07/2018	10:52:43	00d 00:05:00.0	41.1	64.0	40.9	29.5	
19/07/2018	10:57:43	00d 00:05:00.0	36.6	58.4	39.9	28.5	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	1 hr	38.2	56.9	38.9	26.8
Mode	1 hr	#N/A	#N/A	40.9	#N/A
Min	1 hr	32.8	48.1	33.6	23.2
Max	1 hr	43.3	64.0	44.9	32.4

NMP1 - Unst Airport - Night

NMP Description	Open fields on access track to Unst airfield. Scattered dwellings along road to north, with Balta Sound inlet to the north
Weather Conditions	Still - no wind. 15C, 60% cloud cover, dry.
Coordinates	HP 65083,15077
File #	
Main Noise Sources	Bird calls.
Secondary Noise Sources	Infrequent vehicles passing by on the nearby road.
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.

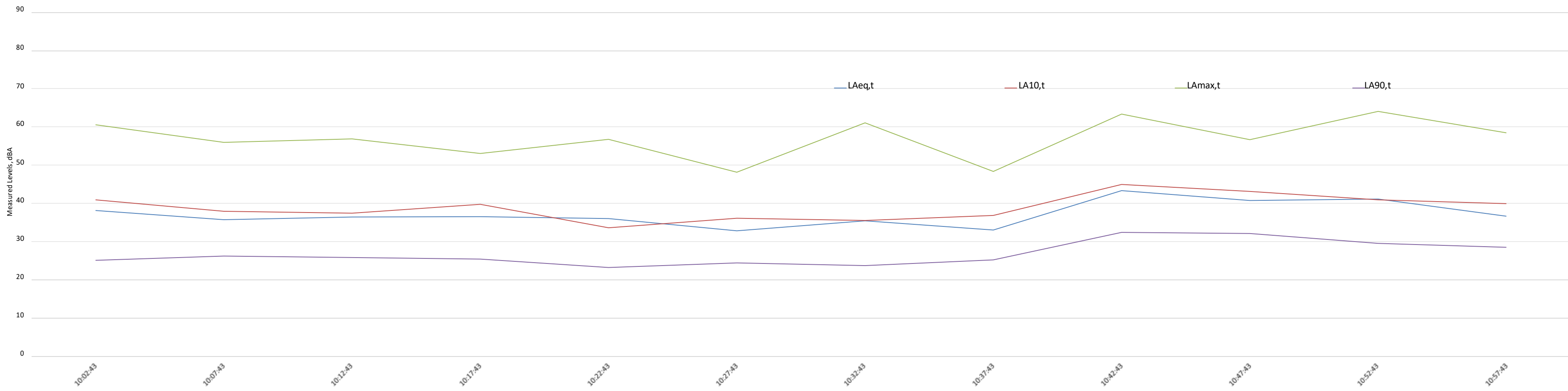


Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	22:59:44	00d 00:05:00.0	32.3	61.4	30.5	16.6	
19/07/2018	23:04:44	00d 00:05:00.0	25.9	42.0	28.5	17.6	
19/07/2018	23:09:44	00d 00:05:00.0	41.8	62.0	36.2	20.6	
19/07/2018	23:14:44	00d 00:05:00.0	40.4	60.8	34.8	18.7	
19/07/2018	23:19:44	00d 00:05:00.0	23.9	43.2	26.1	19.0	
19/07/2018	23:24:44	00d 00:05:00.0	25.7	36.2	28.7	20.7	
19/07/2018	23:29:44	00d 00:05:00.0	41.6	60.2	39.1	18.1	
19/07/2018	23:34:44	00d 00:01:51.5	34.9	60.1	28.3	17.4	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	35 min	37.6	53.2	31.5	18.6
Mode	35 min	#N/A	#N/A	#N/A	#N/A
Min	35 min	23.9	36.2	26.1	16.6
Max	35 min	41.8	62.0	39.1	20.7

NMP2 - North Dale - Day

NMP Description	Open field near access track leading to Saxa Vord radar station.
Weather Conditions	Dry, 15°C, overcast, low - moderate wind speed (<5 m/s)
Coordinates	HP62478,08115
File #	
Main Noise Sources	Bird calls, sheep bleating, rustling of grasses in the wind.
Secondary Noise Sources	Very infrequent road traffic. Very distant/almost inaudible low hum.
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.

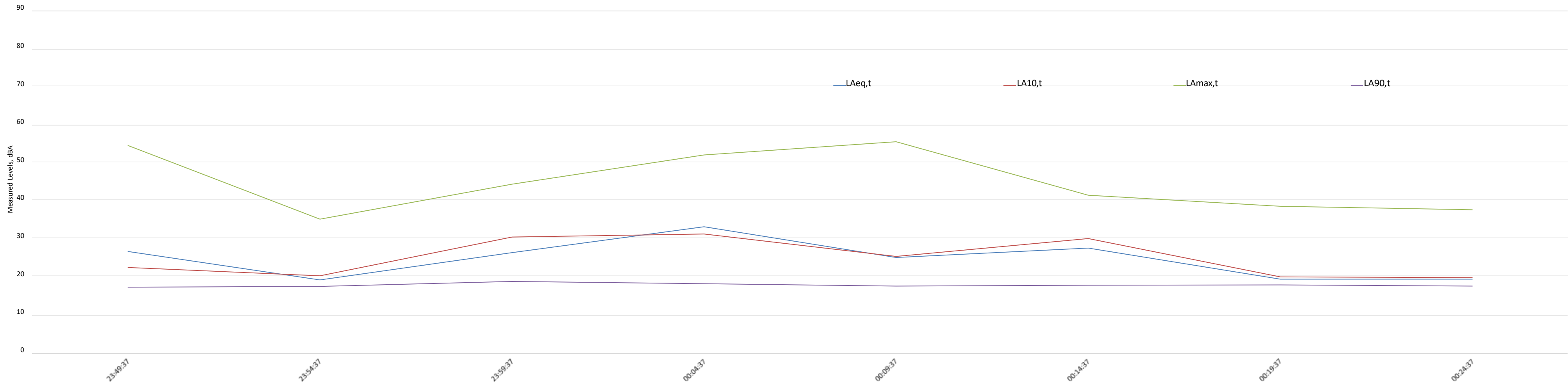


Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	11:29:47	00d 00:05:00.0	38.4	55.2	40.5	30.9	
19/07/2018	11:34:47	00d 00:05:00.0	37.1	55.5	39.5	30.9	
19/07/2018	11:39:47	00d 00:05:00.0	37.4	52.4	40.2	31.2	
19/07/2018	11:44:47	00d 00:05:00.0	39.5	54.7	42.3	31.9	
19/07/2018	11:49:47	00d 00:05:00.0	37.7	54.0	40.1	33.0	
19/07/2018	11:54:47	00d 00:05:00.0	37.7	51.1	40.5	31.4	
19/07/2018	11:59:47	00d 00:05:00.0	36.4	53.1	39.2	31.5	
19/07/2018	12:04:47	00d 00:05:00.0	36.6	51.4	39.5	31.5	
19/07/2018	12:09:47	00d 00:05:00.0	37.2	53.9	39.6	31.6	
19/07/2018	12:14:47	00d 00:05:00.0	38.2	53.4	40.6	33.3	
19/07/2018	12:19:47	00d 00:05:00.0	40.8	56.6	41.9	34.0	
19/07/2018	12:24:47	00d 00:05:00.0	41.7	59.7	43.4	33.2	
19/07/2018	12:29:47	00d 00:05:00.0	38.2	53.0	41.4	31.9	
19/07/2018	12:34:47	00d 00:05:00.0	39.0	50.1	41.7	34.1	
19/07/2018	12:39:47	00d 00:05:00.0	39.2	49.0	42.4	34.2	
19/07/2018	12:44:47	00d 00:05:00.0	44.6	62.8	46.1	35.1	
19/07/2018	12:49:47	00d 00:05:00.0	40.0	50.9	43.0	34.5	
19/07/2018	12:54:47	00d 00:05:00.0	41.2	53.7	44.4	35.3	
19/07/2018	12:59:47	00d 00:00:00.5	40.2	43.9	43.7	36.8	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	1.5hr	39.5	53.4	41.6	33.0
Mode	1.5hr	37.7	#N/A	40.5	30.9
Min	1.5hr	36.4	43.9	39.2	30.9
Max	1.5hr	44.6	62.8	46.1	36.8

NMP2 - North Dale - Night

NMP Description	Open field near access track leading to Saxa Vord radar station.
Weather Conditions	Dry, no wind, 15C, 75% cloud cover
Coordinates	HP62478,08115
File #	
Main Noise Sources	Barely audible running water in nearby small watercourse.
Secondary Noise Sources	
Sound Level Meter Settings	

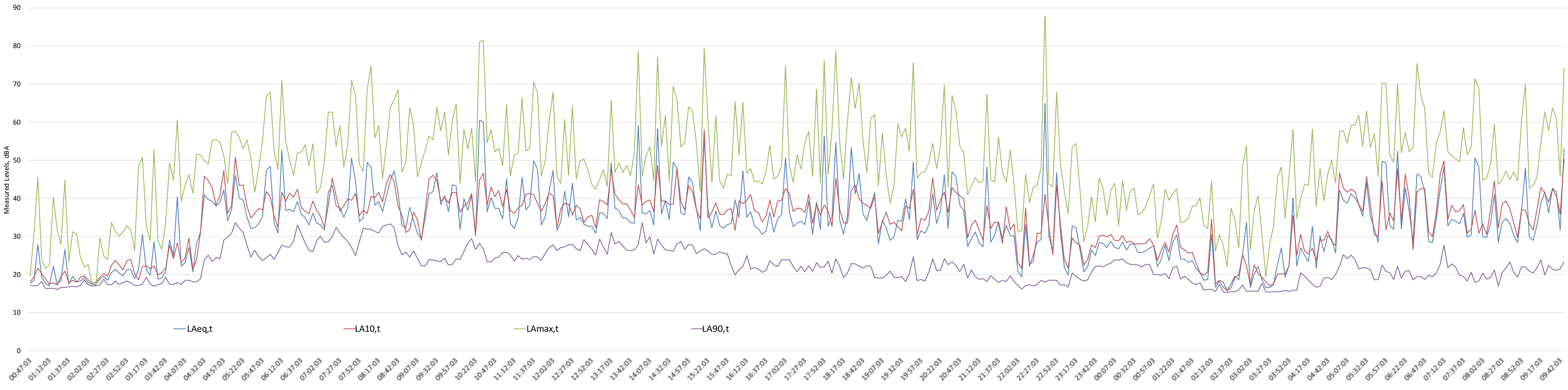


Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	23:49:37	00d 00:05:00.0	26.4	54.3	22.2	17.0	
19/07/2018	23:54:37	00d 00:05:00.0	18.9	34.9	20.0	17.2	
19/07/2018	23:59:37	00d 00:05:00.0	26.1	44.1	30.2	18.5	
20/07/2018	00:04:37	00d 00:05:00.0	32.9	51.8	31.0	17.9	
20/07/2018	00:09:37	00d 00:05:00.0	24.8	55.3	25.1	17.3	
20/07/2018	00:14:37	00d 00:05:00.0	27.3	41.2	29.8	17.5	
20/07/2018	00:19:37	00d 00:05:00.0	19.1	38.3	19.7	17.6	
20/07/2018	00:24:37	00d 00:05:00.0	19.1	37.4	19.5	17.3	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	40 min	27.1	44.7	24.7	17.5
Mode	40 min	19.1	#N/A	#N/A	17.3
Min	40 min	18.9	34.9	19.5	17.0
Max	40 min	32.9	55.3	31.0	18.5

NMP3 - Saxa Vord - long term

NMP Description	Grounds of Saxa Vord hostel
Weather Conditions	Dry, no wind, 15C, 75% cloud cover
Coordinates	
File #	
Main Noise Sources	Wind and birdsong
Secondary Noise Sources	Infrequent traffic movements. People moving around the grounds.
Sound Level Meter Settings	

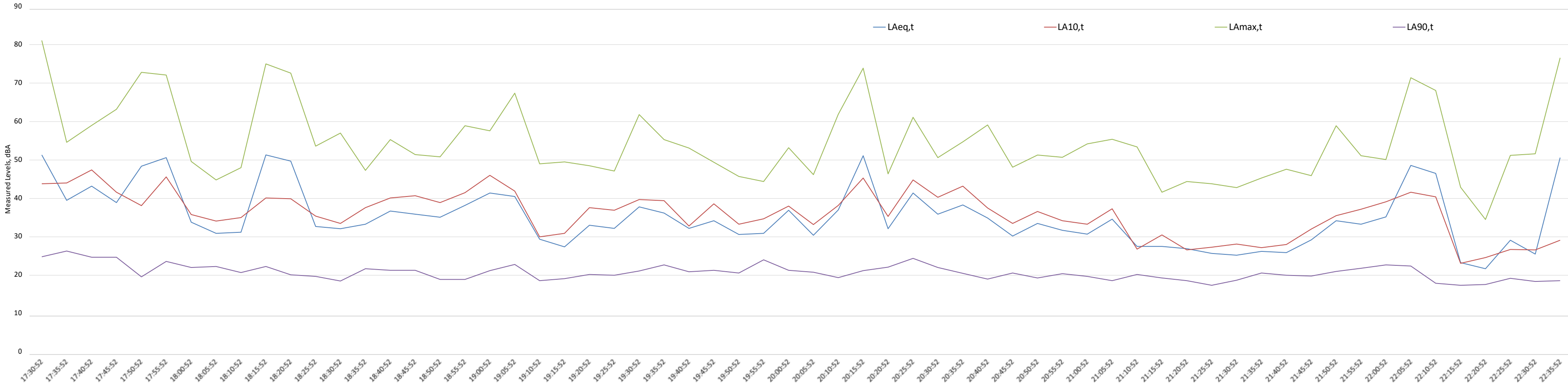


Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	30 hr	44.8	51.4	33.8	22.2
Mode	30 hr	36.5	45.6	39.3	17.4
Min	30 hr	15.7	19.3	15.8	15.3
Max	30 hr	64.9	92.2	58.0	33.6

NMP3 - Saxa Vord - Day

MAP Location (Google Earth Screenshot)

NMP Description	Open field near access track leading to Saxa Vord radar station.
Weather Conditions	Dry, with light to moderate wind (5 m/s), 15°C, 70% RH
Coordinates	HP 64404,13441
File #	
Main Noise Sources	Bird calls. Infrequent vehicles passing by on the nearby road.
Secondary Noise Sources	Distant sheep bleating
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.

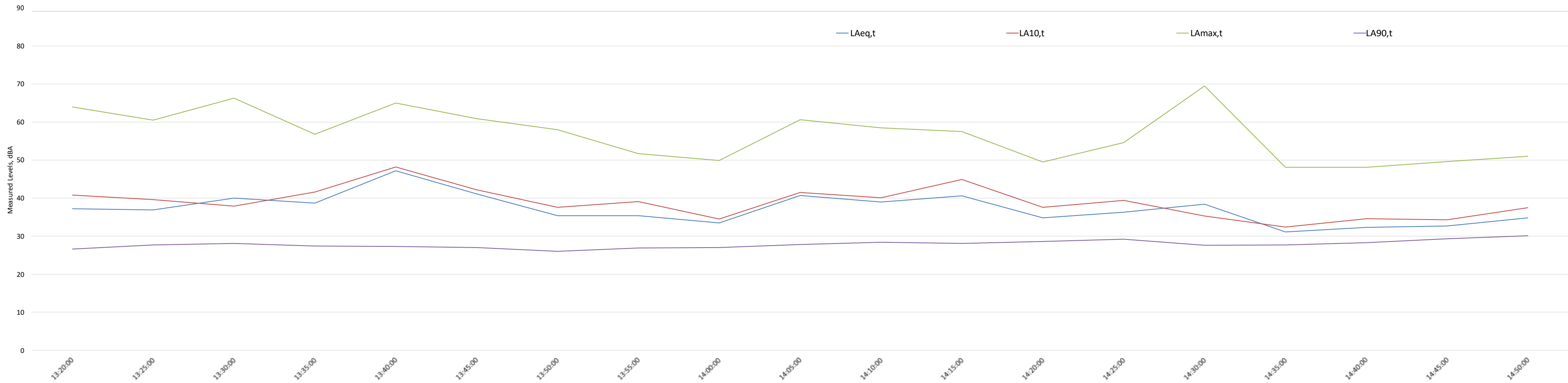


Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	5 hr	42.4	54.6	36.1	20.7
Mode	5 hr	51.3	55.3	41.6	21.3
Min	5 hr	21.7	34.5	23.1	17.4
Max	5 hr	51.3	81.1	47.4	26.3

NMP5 Skaw - Day

MAP Location (Google Earth Screens hot)

NMP Descript ion	
Weather Condit ions	Moderate wind (5 m/s), 15°C, 70% RH, with wind increasingly gusty. Meas urem ent abandoned due to onset of rain and increased wind speed.
Coordinates	HP 65083,15077
File #	
Main Noise Sources	Bird calls, running water in near by small burn.
Secondary Noise Sources	Ocasional bangs from closing of gate in fence. Vehicle engines from nearby car park and farmer's quadbike. Pic kup towing very rattly trailer
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.

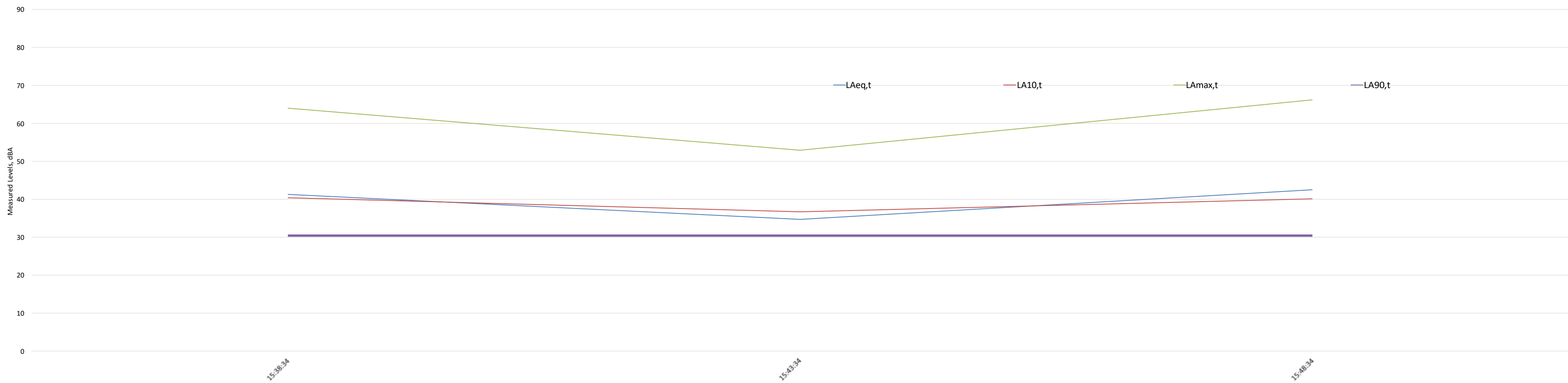


Date	Start Time	Measure me nt Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	13:20:00	00d 00:05:00.0	37.2	64.0	40.8	26.6	
19/07/2018	13:25:00	00d 00:05:00.0	36.9	60.5	39.6	27.7	
19/07/2018	13:30:00	00d 00:05:00.0	40.0	66.3	37.9	28.1	
19/07/2018	13:35:00	00d 00:05:00.0	38.7	56.8	41.6	27.4	
19/07/2018	13:40:00	00d 00:05:00.0	47.2	65.0	48.2	27.3	Pickup towing very rattly trailer leaves farm
19/07/2018	13:45:00	00d 00:05:00.0	41.1	60.9	42.2	27.0	
19/07/2018	13:50:00	00d 00:05:00.0	35.4	58.0	37.6	26.0	
19/07/2018	13:55:00	00d 00:05:00.0	35.4	51.7	39.1	26.9	
19/07/2018	14:00:00	00d 00:05:00.0	33.5	49.9	34.5	27.0	
19/07/2018	14:05:00	00d 00:05:00.0	40.7	60.6	41.5	27.8	
19/07/2018	14:10:00	00d 00:05:00.0	39.0	58.5	40.1	28.4	
19/07/2018	14:15:00	00d 00:05:00.0	40.6	57.5	44.9	28.1	
19/07/2018	14:20:00	00d 00:05:00.0	34.8	49.5	37.6	28.6	
19/07/2018	14:25:00	00d 00:05:00.0	36.3	54.6	39.4	29.2	
19/07/2018	14:30:00	00d 00:05:00.0	38.4	69.5	35.3	27.6	
19/07/2018	14:35:00	00d 00:05:00.0	31.1	48.1	32.4	27.7	
19/07/2018	14:40:00	00d 00:05:00.0	32.3	48.1	34.6	28.3	
19/07/2018	14:45:00	00d 00:05:00.0	32.7	49.6	34.3	29.3	
19/07/2018	14:50:00	00d 00:01:59.0	34.8	51.0	37.5	30.1	

Per iod	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	1.5 hr	39.1	56.8	38.9	27.8
Mode	1.5 hr	35.4	48.1	37.6	27.7
Min	1.5 hr	31.1	48.1	32.4	26.0
Max	1.5 hr	47.2	69.5	48.2	30.1

NMP4 Battles Kirk - Day

NMP Description	
Weather Conditions	Moderate wind (5 m/s), 15°C, 70% RH, with wind increasingly gusty. Measurement abandoned due to onset of rain and increased wind speed.
Coordinates	HP 65083,15077
File #	
Main Noise Sources	Bird calls. Infrequent vehicles passing by on the nearby road.
Secondary Noise Sources	Distant sheep bleating
Sound Level Meter Settings	5min averaging period, A-wt, Fast averaging.



Date	Start Time	Measurement Time	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$	Notes
19/07/2018	15:38:34	00d 00:05:00.0	41.3	64.0	40.4	30.6	
19/07/2018	15:43:34	00d 00:05:00.0	34.7	52.9	36.7	30.7	
19/07/2018	15:48:34	00d 00:05:00.0	42.5	66.2	40.1	30.1	

Period	Time (T)	$L_{Aeq,t}$	$L_{Amax,t}$	$L_{A10,t}$	$L_{A90,t}$
Mean	15 min	40.6	61.0	39.1	30.5
Mode	15 min	#N/A	#N/A	#N/A	#N/A
Min	15 min	34.7	52.9	36.7	30.1
Max	15 min	42.5	66.2	40.4	30.7

Appendix 8.4 Traffic Flow Data

Site number: 80332

Site details

Region	Scotland
Local authority	Shetland Islands
Road name	A968
Road classification	'A' road
Managed by	Local authority
Road type	Major
Start junction	Belmont ferry
End junction	B9086
Link length	16.50km (10.25 miles)
Easting, northing	460000, 1205400
Latitude, longitude	60.72720200, -0.90191201

Location

Annual Average daily flow

Year	Count method	Pedal cycles	Two wheeled motor vehicles	Cars and taxis	Buses and coaches	Light goods vehicles	Heavy goods vehicles	All motor vehicles
2023	Estimated using previous year's AADF on this link	4	6	361	0	122	11	501
2022	Estimated using previous year's AADF on this link	4	7	353	0	120	11	490
2021	Estimated using previous year's AADF on this link	4	6	329	0	107	11	453
2020	Manual count	6	6	300	0	94	10	410
2019	Estimated using previous year's AADF on this link	2	0	333	0	150	11	494
2018	Estimated using previous year's AADF on this link	1	0	332	0	151	11	493
2017	Estimated using previous year's AADF on this link	1	0	334	0	144	11	488
2016	Estimated using previous year's AADF on this link	1	0	334	0	136	10	480
2015	Estimated using previous year's AADF on this link	1	0	330	0	126	10	466
2014	Estimated using previous year's AADF on this link	1	0	325	0	118	10	453
2013	Estimated using previous year's AADF on this link	2	0	321	0	109	9	439
2012	Estimated using previous year's AADF on this link	2	0	320	0	101	10	431
2011	Estimated using previous year's AADF on this link	2	0	326	0	105	10	441
2010	Estimated using previous year's AADF on this link	2	0	328	0	100	10	438

Appendix 9 -

Appendix 10.1 Planning Policy Screening

Scotland's National Marine Plan Policies Screening Assessment

From: https://www.gov.scot/publications/scotlands-national-marine-plan/pages/1/

Marine Plan Policy Listing and Screening in Relation to the Proposed Development

Policy ID	Policy Title	Policy Text	Screening Rationale	Relevant Section of the AEE
GEN 1	General planning principle	There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 2	Economic benefit	Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 3	Social benefit	Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 4	Co-existence	Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision making processes, when consistent with policies and objectives of this Plan.	Policy screened for consideration in AEE	Chapter 10
GEN 5	Climate change	Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.	Policy screened for consideration in AEE	Chapter 4
GEN 6	Historic environment	Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.	Policy screened for consideration in AEE	Chapter 10
GEN 7	Landscape/seascape	Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account.	Policy screened for consideration in AEE	Chapter 2
GEN 8	Coastal process and flooding	Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.	Policy screened for consideration in AEE	Chapter 4
GEN 9	Natural heritage	Development and use of the marine environment must: (a) Comply with legal requirements for protected areas and protected species. (b) Not result in significant impact on the national status of Priority Marine Features. (c) Protect and, where appropriate, enhance the health of the marine area.	Policy screened for consideration in AEE	Chapter 10
GEN 10	Invasive non-native species	Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.	Policy screened for consideration in AEE	N/A
GEN 11	Marine litter	Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.	Policy screened for consideration in AEE	Chapter 10
GEN 12	Water quality and resource	Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.	Policy screened for consideration in AEE	Chapter 10
GEN 13	Noise	Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.	Policy screened for consideration in AEE	Chapter 8
GEN 14	Air quality	Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.	Policy screened for consideration in AEE	Chapter 7
GEN 15	Planning alignment A	Marine and terrestrial plans should align to support marine and land-based components required by development and seek to facilitate appropriate access to the shore and sea.	Policy screened for consideration in AEE	Chapter 10
GEN 16	Planning alignment B	Marine plans should align and comply where possible with other statutory plans and should consider objectives and policies of relevant non-statutory plans where appropriate to do so. <applies to inshore waters only>	Policy screened for consideration in AEE	N/A
GEN 17	Fairness	All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.	Policy screened for consideration in AEE	Chapter 10
GEN 18	Engagement	Early and effective engagement should be undertaken with the general public and all interested stakeholders to facilitate planning and consenting processes.	Policy screened for consideration in AEE	Chapter 10
GEN 19	Sound evidence	Decision making in the marine environment will be based on sound scientific and socio-economic evidence.	Policy screened for consideration in AEE	Chapter 10
GEN 20	Adaptive management	Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy.	Policy screened for consideration in AEE	Chapter 10
GEN 21	Cumulative impacts	Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.	Policy screened for consideration in AEE	Chapter 10
FISHERIES 1		Taking account of the EU's Common Fisheries Policy, Habitats Directive, Birds Directive and Marine Strategy Framework Directive, marine planners and decision makers should aim to ensure: - Existing fishing opportunities and activities are safeguarded wherever possible. - An ecosystem-based approach to the management of fishing which ensures sustainable and resilient fish stocks and avoids damage to fragile habitats. - Protection for vulnerable stocks (in particular for juvenile and spawning stocks through continuation of sea area closures where appropriate). - Improved protection of the seabed and historical and archaeological remains requiring protection through effective identification of high-risk areas and management measures to mitigate the impacts of fishing, where appropriate. - That other sectors take into account the need to protect fish stocks and sustain healthy fisheries for both economic and conservation reasons. - Delivery of Scotland's international commitments in fisheries, including the ban on discards. - Mechanisms for managing conflicts between fishermen and/or between the fishing sector and other users of the marine environment.	Policy screened for consideration in AEE	Chapter 10
FISHERIES 2		The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on fishing: - The cultural and economic importance of fishing, in particular to vulnerable coastal communities. - The potential impact (positive and negative) of marine developments on the sustainability of fish and shellfish stocks and resultant fishing opportunities in any given area. - The environmental impact on fishing grounds (such as nursery, spawning areas), commercially fished species, habitats and species more generally. - The potential effect of displacement on: fish stocks; the wider environment; use of fuel; socio-economic costs to fishers and their communities and other marine users.	Policy screened for consideration in AEE	Chapter 10

FISHERIES 3		Where existing fishing opportunities or activity cannot be safeguarded, a Fisheries Management and Mitigation Strategy should be prepared by the proposer of development or use, involving full engagement with local fishing interests (and other interests as appropriate) in the development of the Strategy. All efforts should be made to agree the Strategy with those interests. Those interests should also undertake to engage with the proposer and provide transparent and accurate information and data to help complete the Strategy. The Strategy should be drawn up as part of the discharge of conditions of permissions granted. The content of the Strategy should be relevant to the particular circumstances and could include: - An assessment of the potential impact of the development or use on the affected fishery or fisheries, both in socio-economic terms and in terms of environmental sustainability. - A recognition that the disruption to existing fishing opportunities/activity should be minimised as far as possible. - Reasonable measures to mitigate any constraints which the proposed development or use may place on existing or proposed fishing activity. - Reasonable measures to mitigate any potential impacts on sustainability of fish stocks (e.g. impacts on spawning grounds or areas of fish or shellfish abundance) and any socio-economic impacts. Where it does not prove possible to agree the Strategy with all interests, the reasons for any divergence of views between the parties should be fully explained in the Strategy and dissenting views should be given a platform within the Strategy to make their case.	Policy screened for consideration in AEE	Chapter 10
FISHERIES 4		Ports and harbours should seek to engage with fishing and other relevant stakeholders at an early stage to discuss any changes in infrastructure that may affect them. Any port or harbour developments should take account of the needs of the dependent fishing fleets with a view to avoiding commercial harm where possible. Where a port or harbour has reached a minimum level of infrastructure required to support a viable fishing fleet, there should be a presumption in favour of maintaining this infrastructure, provided there is an ongoing requirement for it to remain in place and that it continues to be fit for purpose.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
FISHERIES 5		Inshore Fisheries Groups (IFGs) should work with all local stakeholders with an interest to agree joint fisheries management measures. These measures should inform and reflect the objectives of regional marine plans. <applies to inshore waters>	Policy not relevant to the Proposed Development (geographic policy)	N/A
AQUACULTURE 1		Marine planners and decision makers should seek to identify appropriate locations for future aquaculture development and use, including the potential use of development planning briefs as appropriate. System carrying capacity (at the scale of a water body or loch system) should be a key consideration.	Policy screened for consideration in AEE	N/A
AQUACULTURE 2		Marine and terrestrial development plans should jointly identify areas which are potentially suitable and sensitive areas which are unlikely to be appropriate for such development, reflecting Scottish Planning Policy and any Scottish Government guidance on the issue. There is a continuing presumption against further marine finfish farm developments on the north and east coasts to safeguard migratory fish species.	Policy screened for consideration in AEE	N/A
AQUACULTURE 3		In relation to nutrient enhancement and benthic impacts, as set out under Locational Guidelines for the Authorisation of Marine Fish Farms in Scottish Waters, fish farm development is likely to be acceptable in Category 3 areas, subject to other criteria being satisfied. A degree of precaution should be applied to consideration of further fish farming development in Category 2 areas and there will be a presumption against further fish farm development in Category 1 areas.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 4		There is a presumption that further sustainable expansion of shellfish farms should be located in designated shellfish waters if these have sufficient capacity to support such development.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 5		Aquaculture developments should avoid and/or mitigate adverse impacts upon the seascape, landscape and visual amenity of an area, following SNH guidance on the siting and design of aquaculture.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 6		New aquaculture sites should not bridge Disease Management Areas although boundaries may be revised by Marine Scotland to take account of any changes in fish farm location, subject to the continued management of risk.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 7		Operators and regulators should continue to utilise a risk based approach to the location of fish farms and potential impacts on wild fish.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 8		Guidance on harassment at designated seal haul out sites should be taken into account and seal conservation areas should also be taken into account in site selection and operation. Seal licences will only be granted where other management options are precluded or have proven unsuccessful in deterrence.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 9		Consenting and licensing authorities should be satisfied that appropriate emergency response plans are in place.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 10		Operators should carry out pre-application discussion and consultation, and engage with local communities and others who may be affected, to identify and, where possible, address any concerns in advance of submitting an application.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 11		Aquaculture equipment, including but not limited to installations, facilities, moorings, pens and nets must be fit for purpose for the site conditions, subject to future climate change. Any statutory technical standard must be adhered to. Equipment and activities should be optimised in order to reduce greenhouse gas emissions.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 12		Applications which promote the use of sustainable biological controls for sea lice (such as farmed wrasse) will be encouraged.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 13		Proposals that contribute to the diversification of farmed species will be supported, subject to other objectives and policies being satisfied.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AQUACULTURE 14		The Scottish Government, aquaculture companies and Local Authorities should work together to maximise benefit to communities from aquaculture development.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
WILD FISH 1		The impact of development and use of the marine environment on diadromous fish species should be considered in marine planning and decision making processes. Where evidence of impacts on salmon and other diadromous species is inconclusive, mitigation should be adopted where possible and information on impacts on diadromous species from monitoring of developments should be used to inform subsequent marine decision making.	Policy screened for consideration in AEE	Chapter 10
OIL & GAS 1		The Scottish Government will work with DECC, the new Oil and Gas Authority and the industry to maximise and prolong oil and gas exploration and production whilst ensuring that the level of environmental risks associated with these activities are regulated. Activity should be carried out using the principles of Best Available Technology (BAT) and Best Environmental Practice. Consideration will be given to key environmental risks including the impacts of noise, oil and chemical contamination and habitat change.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
OIL & GAS 2		Where re-use of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. Re-use or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
OIL & GAS 3		Supporting marine and coastal infrastructure for oil and gas developments, including for storage, should utilise the minimum space needed for activity and should take into account environmental and socio-economic constraints.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
OIL & GAS 4		All oil and gas platforms will be subject to 9 nautical mile consultation zones in line with Civil Aviation Authority guidance.	Policy screened for consideration in AEE	Chapter 10
OIL & GAS 5		Consenting and licensing authorities should have regard to the potential risks, both now and under future climates, to oil and gas operations in Scottish waters, and be satisfied that installations are appropriately sited and designed to take account of current and future conditions.	Policy screened for consideration in AEE	Chapter 10
OIL & GAS 6		Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.	Policy screened for consideration in AEE	Chapter 10
CCS 1		CCS commercialisation projects or developments should be supported through an alignment of marine and terrestrial planning processes, particularly where proposals allow timely deployment of CCS to re-use suitable existing redundant oil and gas infrastructure.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CCS 2		Consideration should be given to the development of marine utility corridors which will allow CCS to capitalise, where possible, on current infrastructure in the North Sea, including shared use of spatial corridors and pipelines.	Policy screened for consideration in AEE	N/A
RENEWABLES 1		Proposals for commercial scale offshore wind and marine renewable energy development should be sited in the Plan Option areas identified through the Sectoral Marine Plan process. Plan Options are considered the preferred strategic locations for the sustainable development of offshore wind and marine renewables. This preference should be taken into account by marine planners and decision makers if alternative development or use of these areas is being considered. Proposals are subject to licensing and consenting processes.	Policy not relevant to the Proposed Development (sector specific policy)	N/A

RENEWABLES 2		Sites with agreements for lease for wave and tidal energy development in the Pentland Firth Strategic Area must be taken into account by marine planners and decision makers if alternative use of these areas, or use which would affect access to these areas, is being considered. Proposals are subject to licensing and consenting processes. Regional Locational Guidance and the Pentland Firth and Orkney Waters Marine Spatial Plans should also be taken into account when reaching decisions.	Policy not relevant to the Proposed Development (geographic policy)	N/A
RENEWABLES 3		Marine planners and decision makers should consider proposals for sustainable development of test and demonstration for offshore wind and marine renewable energy development on a case-by-case basis where sites are identified. This preference should be taken into account by marine planners and decision makers if alternative development or use of these areas is being considered. Regional Locational Guidance should be taken into account and proposals are subject to licensing and consenting processes.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 4		Applications for marine licences and consents relating to offshore wind and marine renewable energy projects should be made in accordance with the Marine Licensing Manual and Marine Scotland's Licensing Policy Guidance.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 5		Marine planners and decision makers must ensure that renewable energy projects demonstrate compliance with Environmental Impact Assessment and Habitats Regulations Appraisal legislative requirements.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 6		New and future planned grid connections should align with relevant sectoral and other marine spatial planning processes, where appropriate, to ensure a co-ordinated and strategic approach to grid planning. Cable and network owners and marine users should also take a joined-up approach to development and activity to minimise impacts on the marine historic and natural environment and other users.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 7		Marine planners and decision makers should ensure infrastructure is fit for purpose now and in future. Consideration should be given to the potential for climate change impacts on coasts vulnerable to erosion.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 8		Developers bringing forward proposals for new developments must actively engage at an early stage with the general public and interested stakeholders of the area to which the proposal relates and of adjoining areas which may be affected.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 9		Marine planners and decision makers should support the development of joint research and monitoring programmes for offshore wind and marine renewables energy development.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
RENEWABLES 10		Good practice guidance for community benefit from offshore wind and renewable energy development should be followed by developers, where appropriate.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
REC & TOURISM 1		Opportunities to promote sustainable development of marine recreation and tourism should be supported.	Policy screened for consideration in AEE	N/A
REC & TOURISM 2		The following key factors should be taken into account when deciding on uses of the marine environment and the potential impact on recreation and tourism: - The extent to which the proposal is likely to adversely affect the qualities important to recreational users, including the extent to which proposals may interfere with the physical infrastructure that underpins a recreational activity. - The extent to which any proposal interferes with access to and along the shore, to the water, use of the resource for recreation or tourism purposes and existing navigational routes or navigational safety. - Where significant impacts are likely, whether reasonable alternatives can be identified for the proposed activity or development. - Where significant impacts are likely and there are no reasonable alternatives, whether mitigation, through recognised and effective measures, can be achieved at no significant cost to the marine recreation or tourism sector interests.	Policy screened for consideration in AEE	N/A
REC & TOURISM 3		Regional marine plans should identify areas that are of recreational and tourism value and identify where prospects for significant development exist, including opportunities to link to the National Long Distance Walking and Cycle Routes, and more localised and/or bespoke recreational opportunities and visitor attractions.	Policy screened for consideration in AEE	N/A
REC & TOURISM 4		Marine and terrestrial planners, marine decision makers and developers should give consideration to the facility requirements of marine recreation and tourism activities, including a focus on support for participation and development in sport. Co-operation and sharing infrastructure and/or facilities, where appropriate, with complementary sectors should be supported as should provision of low carbon transport options.	Policy screened for consideration in AEE	N/A
REC & TOURISM 5		Marine planners and decision makers should support enhancement to the aesthetic qualities, coastal character and wildlife experience of Scotland's marine and coastal areas, to the mutual benefit of the natural environment, human quality of life and the recreation and tourism sectors.	Policy screened for consideration in AEE	N/A
REC & TOURISM 6		Codes of practice for invasive non-native species and Marine Wildlife Watching should be complied with.	Policy screened for consideration in AEE	N/A
TRANSPORT 1		Navigational safety in relevant areas used by shipping now and in the future will be protected, adhering to the rights of innocent passage and freedom of navigation contained in UN Convention on the Law of the Sea (UNCLOS). The following factors will be taken into account when reaching decisions regarding development and use: - The extent to which the locational decision interferes with existing or planned routes used by shipping, access to ports and harbours and navigational safety. This includes commercial anchorages and defined approaches to ports. - Where interference is likely, whether reasonable alternatives can be identified. - Where there are no reasonable alternatives, whether mitigation through measures adopted in accordance with the principles and procedures established by the International Maritime Organization can be achieved at no significant cost to the shipping or ports sector.	Policy screened for consideration in AEE	Chapter 10
TRANSPORT 2		Marine development and use should not be permitted where it will restrict access to, or future expansion of, major commercial ports or existing or proposed ports and harbours which are identified as National Developments in the current NPF or as priorities in the National Renewables Infrastructure Plan. Regional marine plans should identify regionally important ports and harbours, giving consideration to social and economic aspects of the port or harbour and the users of the facility subject to policies and objectives of this Plan. Regional plans should consider setting out criteria against which proposed activities and developments should be evaluated. <applies to inshore waters only>	Policy not relevant to the Proposed Development (sector specific policy)	N/A
TRANSPORT 3		Ferry routes and maritime transport to island and remote mainland areas provide essential connections and should be safeguarded from inappropriate marine development and use that would significantly interfere with their operation. Developments will not be consented where they will unacceptably interfere with lifeline ferry services.	Policy screened for consideration in AEE	Chapter 10
TRANSPORT 4		Maintenance, repair and sustainable development of port and harbour facilities in support of other sectors should be supported in marine planning and decision making. <applies to inshore waters only>	Policy not relevant to the Proposed Development (sector specific policy)	N/A
TRANSPORT 5		Port and harbour operators should take into account future climate change and extreme water level projections, and where appropriate take the necessary steps to ensure their ports and harbours remain viable and resilient to a changing climate. Climate and sea level projections should also be taken into account in the design of any new ports and harbours, or of improvements to existing facilities. <applies to inshore waters only>	Policy not relevant to the Proposed Development (sector specific policy)	N/A
TRANSPORT 6		Marine planners and decision makers and developers should ensure displacement of shipping is avoided where possible to mitigate against potential increased journey lengths (and associated fuel costs, emissions and impact on journey frequency) and potential impacts on other users and ecologically sensitive areas.	Policy screened for consideration in AEE	Chapter 10
TRANSPORT 7		Marine and terrestrial planning processes should co-ordinate to: - Provide co-ordinated support to ports, harbours and ferry terminals to ensure they can respond to market influences and provide support to other sectors with necessary facilities and transport links. - Consider spatial co-ordination of ferries and other modes of transport to promote integrated and sustainable travel options.	Policy not relevant to the Proposed Development (sector specific policy)	N/A

CABLES 1		Cable and network owners should engage with decision makers at the early planning stage to notify of any intention to lay, repair or replace cables before routes are selected and agreed. When making proposals, cable and network owners and marine users should evidence that they have taken a joined-up approach to development and activity to minimise impacts, where possible, on the marine historic and natural environment, the assets, infrastructures and other users. Appropriate and proportionate environmental considertion and risk assessments should be provided which may include cable protection measures and mitigation plans. Any deposit, removal or dredging carried out for the purpose of executing emergency inspection or repair works to any cable is exempt from the marine licensing regime with approval by Scottish Ministers. However, cable replacement requires a marine licence. Marine Licensing Guidance should be followed when considering any cable development and activity.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CABLES 2		The following factors will be taken into account on a case by case basis when reaching decisions regarding submarine cable development and activities: - Cables should be suitably routed to provide sufficient requirements for installation and cable protection. - New cables should implement methods to minimise impacts on the environment, seabed and other users, where operationally possible and in accordance with relevant industry practice. - Cables should be buried to maximise protection where there are safety or seabed stability risks and to reduce conflict with other marine users and to protect the assets and infrastructure. - Where burial is demonstrated not to be feasible, cables may be suitably protected through recognised and approved measures (such as rock or mattress placement or cable armouring) where practicable and cost-effective and as risk assessments direct. - Consideration of the need to reinstate the seabed, undertake post-lay surveys and monitoring and carry out remedial action where required.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CABLES 3		A risk-based approach should be applied by network owners and decision makers to the removal of redundant submarine cables, with consideration given to cables being left in situ where this would minimise impacts on the marine historic and natural environment and other users.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
CABLES 4		When selecting locations for land-fall of power and telecommunications equipment and cabling, developers and decision makers should consider the policies pertaining to flooding and coastal protection in Chapter 4, and align with those in Scottish Planning Policy and Local Development Plans.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
DEFENCE 1		To maintain operational effectiveness in Scottish waters used by the armed services, development and use will be managed in these areas: - Naval areas including bases and ports: Safety of navigation and access to naval bases and ports will be maintained. The extent to which a development or use interferes with access or safety of navigation, and whether reasonable alternatives can be identified, will be taken into account by consenting bodies. Proposals for development and use should be discussed with the MOD at an early stage in the process. - Firing Danger Areas (Map 13): Development of new permanent infrastructure is unlikely to be compatible with the use of Firing Danger Areas by the MOD. Permitted activities may have temporal restrictions imposed. Proposals for development and use should be discussed with the MOD at an early stage in the process. - Exercise Areas (Map 13): Within Exercise Areas, activities may be subject to temporal restrictions. Development and use that either individually or cumulatively obstructs or otherwise prevents the defence activities supported by an exercise area may not be permitted. Proposals for development and use should be discussed with the MOD at an early stage in the process. - Communications: Navigations and surveillance including radar: Development and use which causes unacceptable interference with radar and other systems necessary for national defence may be prohibited if mitigation cannot be determined. Proposals for development and use should be discussed with the MOD at an early stage in the process.	Policy not relevant to the Proposed Development (geographic policy)	N/A
DEFENCE 2		For the purposes of national defence, the MOD may establish by-laws for exclusions and closures of sea areas. In most areas this will mean temporary exclusive use of areas by the MOD. Where potential for conflict with other users is identified, appropriate mitigation will be identified and agreed with the MOD, prior to planning permission, a marine licence, or other consent being granted.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
DEFENCE 3		The established code of conduct for managing fishing and military activity detailed in the documents 'Fishing Vessels Operating in Submarine Exercise Areas' [155] and 'Fishing Vessel Avoidance: The UK Code of Practice Fishing Vessel Avoidance' [156] will be adhered to.	Policy not relevant to the Proposed Development (sector specific policy)	N/A
AGGREGATES 1		Marine planners and decision makers should consider the impacts of other development or activity on areas of marine aggregate or mineral resource. Where an interaction is identified, consideration should be given to whether there are permissions for aggregate or mineral extraction and whether they require any degree of safeguarding.	Policy not relevant to the Proposed Development (geographic policy)	N/A
AGGREGATES 2		Decision makers should ensure all the necessary environmental issues are considered and safeguards are in place when determining whether any proposed marine aggregate dredging is considered to be environmentally acceptable and is in accordance with the other policies and objectives of this Plan.	Policy not relevant to the Proposed Development (sector specific policy)	N/A

Shetland Local Development Plan Policies Screening Assessment

From: https://www.shetland.gov.uk/downloads/file/1930/local-development-plan-2014

Local Development Plan Listing and Screening in Relation to the Proposed Development

Policy ID	Policy Title	Policy Text	Screening Rationale	Relevant Section of the AEE
GP 1	Sustainable Development	Development will be planned to meet the economic and social needs of Shetland in a manner that does not compromise the ability of future generations to meet their own needs and to enjoy the area's high quality environment. Tackling climate change and associated risks is a major consideration for all development proposals. New residential, employment, cultural, educational and community developments should be in or adjacent to existing settlements that have basic services and infrastructure in order to enhance their viability and vitality and facilitate ease of access for all. This will be achieved through Allocations, Sites with Development Potential and Areas of Best Fit.	Policy not relevant to the Proposed Development	Chapter 2

GP 2	General Requirements for All Development	Applications for new buildings or for the conversion of existing buildings should meet all of the following General Requirements: a. Developments should not adversely affect the integrity or viability of sites designated for their landscape and natural heritage value. b. Development should not occur any lower than 5 metres Above Ordnance Datum (Newlyn) unless the development meets the requirements of Policy WD1; c. Development should be located, constructed and designed so as to minimise the use of energy and to adapt to impacts arising from climate change, such as the increased probability of flooding; water stress, such as water supply; health or community impacts as a result of extreme climatic events; and a change in richness of biodiversity. d. Suitable water, waste water and surface water drainage must be provided; e. All new buildings shall avoid a specified and rising proportion of the projected greenhouse gas emissions from their use, through the installation and operation of low and zero-carbon generating technologies (LZCGT). The proportion of such emissions shall be specified in the council's Supplementary Guidance – Design. That guidance will also set out the approach to existing buildings which are being altered or extended, including historic buildings, and the approach to applications where developers are able to demonstrate that there are significant technical constraints to using on-site low and zero carbon generating technologies. f. Suitable access, car parking and turning should be provided; g. Development should not adversely affect areas, buildings or structures of archaeological, architectural or historic interest; h. Development should not sterilise mineral reserves; i. Development should not sterilise allocated sites as identified within the Shetland Local Development Plan; j. Development should not have a significant adverse effect on existing uses; k. Development should not compromise acceptable health and safety standards or levels; l. Development should be consistent with National Planning Policy, other Local Development Plan policies and Supplementary Guidance.	Policy not relevant to the Proposed Development	N/A
GP 3	All Development: Layout and Design	All new development should be sited and designed to respect the character and local distinctiveness of the site and its surroundings. The proposed development should make a positive contribution to: • maintaining identity and character • ensuring a safe and pleasant space • ensuring ease of movement and access for all • a sense of welcome • long term adaptability, and • good use of resources The Planning Authority may request a Masterplan and/ or Design and Access Statement in support of development proposals. A Masterplan should be submitted with applications where Major Development is proposed; Major Development is defined in the Town and Country Planning (Hierarchy of Developments) (Scotland) Regulations 2009, Reg 2 (1). Further details for these requirements are set out in Supplementary Guidance.	Policy not relevant to the Proposed Development	N/A
NH 1	International and National Designations	Any development proposal that is likely to have a significant effect on an internationally important site, (Special Area of Conservation (SAC), Special Protection Areas (SPA) or Ramsar Sites) and is not directly connected with or necessary to the conservation management of that site will be subject to an assessment of the implications for the site's conservation objectives. Development that could have a significant effect on a site will only be permitted where: • An appropriate assessment has demonstrated that it will not adversely affect the integrity of the site, or • There are no alternative solutions, and • There are imperative reasons of over-riding public interest that may, for sites not hosting a priority habitat type and/or priority species, be of a social or economic nature. Development that affects a National Scenic Area (NSA), National Nature Reserve (NNR) or a Site of Special Scientific Interest (SSSI) will only be permitted where: • It will not adversely affect the integrity of the area or the qualities or protected features for which it has been designated, or • Any such adverse effects are clearly outweighed by social, environmental or economic benefits of national importance.	Policy screened for consideration in AEE	Chapter 2
NH 2	Protected Species	Where there is good reason to suggest that a species protected under the Wildlife and Countryside Act 1981 (as amended), Annex IV of the Habitats Directive or Annex 1 of the Birds Directive is present on site, or may be affected by a proposed development, the Council will require any such presence to be established. If such a species is present, a plan should be provided to avoid or mitigate any adverse impacts on the species, prior to determining the application. Planning permission will not be granted for development that would be likely to have an adverse effect on a European Protected Species unless the Council is satisfied that: • The development is required for preserving public health or public safety or for other imperative reasons of overriding public interest including those of a social or economic nature and beneficial consequences of primary importance for the environment; and • There is no satisfactory alternative; and • The development will not be detrimental to the maintenance of the population of the European Protected Species concerned at a favourable conservation status in their natural range. Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedule 5 (animals) or 8 (plants) of the Wildlife and Countryside Act 1981 (as amended) unless the Council is satisfied that: • Undertaking the development will give rise to, or contribute towards the achievement of, a significant social, economic or environmental benefit; and • There is no satisfactory solution. Planning permission will not be granted for development that would be likely to have an adverse effect on a species protected under Schedules 1, 1A or A1 (birds) of the Wildlife and Countryside Act 1981 (as amended), unless the Council is satisfied that: o The development is required for preserving public health or public safety; and o There is no other satisfactory solution. Applicants should submit supporting evidence for any development meeting these criteria, demonstrating both the need for the development and that a full range of possible alternative courses of action have been properly examined and none found to acceptably meet the need identified. The Council will apply the precautionary principle where the impacts of a proposed development on natural heritage are uncertain but potentially significant. Where development is constrained on the grounds of uncertainty, the potential for research, surveys or assessments to remove or reduce uncertainty should be considered.	Policy screened for consideration in AEE	Chapters 5, 6 and 10

NH 3	Furthering the Conservation of Biodiversity	Development will be considered against the Council's obligation to further the conservation of biodiversity and the ecosystem services it delivers. The extent of these measures should be relevant and proportionate to the scale of the development. Proposals for development that would have a significant adverse effect on habitats or species identified in the Shetland Local Biodiversity Action Plan, Scottish Biodiversity List, UK Biodiversity Action Plan, Annexes I and II of the Habitats Directive, Annex I of the Birds Directive (if not included in Schedule 1 of the Wildlife and Countryside Act) or on the ecosystem services of biodiversity, including any cumulative impact, will only be permitted where it has been demonstrated by the developer that; • The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of habitat or populations of species; and • Any harm or disturbance to the ecosystem services, continuity and integrity of the habitats or species is avoided, or reduced to acceptable levels by mitigation.	Policy screened for consideration in AEE	Chapters 5, 6 and 10
NH 4	Local Designations	Development that affects a Local Nature Conservation Site or Local Landscape Area will only be permitted where: • It will not adversely affect the integrity of the area or the qualities for which it has been identified; or • Any such effects are clearly outweighed by social, environmental or economic benefits.	Policy not relevant to the Proposed Development	N/A
NH 6	Geodiversity	Development will only be permitted where appropriate measures are taken to protect and/or enhance important geological and geomorphological resources and sites, including those of educational or research value. Proposals that will have an unavoidable effect on geodiversity will only be permitted where it has been demonstrated that: • The development will have benefits of overriding public interest including those of a social or economic nature that outweigh the local, national or international contribution of the affected area in terms of its geodiversity; • Any loss of geodiversity is reduced to acceptable levels by mitigation, and a record is made prior to any loss. For certain scales of development where a soil management plan is required, reference should also be made to geodiversity on site.	Policy not relevant to the Proposed Development	N/A
NH 7	Water Environment	Development will only be permitted where appropriate measures are taken to protect the marine and freshwater environments to an extent that is relevant and proportionate to the scale of development. Development adjacent to a watercourse or water body must be accompanied by sufficient information to enable a full assessment of the likely effects. Where there is potential for the development to have an adverse impact the applicant/developer must demonstrate that: • There will be no deterioration in the ecological status of the watercourse or water body; • It does not encroach on any existing buffer strips and that access to these buffer strips has been maintained; and • Both during the construction phase and after completion it would not significantly affect: o Water quality flows in adjacent watercourses or areas downstream o Natural flow patterns and sediment transport processes in all water bodies or watercourses.	Policy screened for consideration in AEE	Chapter 10, Sections 10.10.106 - 10.10.114
HE 1	Historic Environment	The Council should presume in favour of the protection, conservation and enhancement of all elements of Shetland's historic environment, which includes buildings, monuments, landscapes and areas.	Policy not relevant to the Proposed Development	N/A
HE 4	Archaeology	Scheduled monuments, designated wrecks and other identified nationally important archaeological resources should be preserved in situ, and within an appropriate setting. Developments that have an adverse effect on scheduled monuments and designated wrecks or the integrity of their settings should not be permitted unless there are exceptional circumstances. All other significant archaeological resources should be preserved in situ wherever feasible. Where preservation in situ is not possible the planning authority should ensure that developers undertake appropriate archaeological excavation, recording, analysis, publication and archiving in advance of and/ or during development.	Policy not relevant to the Proposed Development	N/A
CST 1	Coastal Development	Proposals for developments and infrastructure in the coastal zone (above Mean Low Water Mark of Ordinary Spring Tides) will only be permitted where the proposal can demonstrate that: • It will not have a significant impact, either individually or cumulatively, on the natural, built environment and cultural heritage resources either in the sea or on land; • The location, scale and design are such that it will not have a significant adverse impact. • It does not result in any deterioration in ecological status or potential for any water body or prevent it from achieving good ecological status in the future; • There is no significant adverse impact on other users of marine resources, and/or neighbouring land. Proposals for marine aquaculture developments or amendments to existing fish farm developments will require to have regard to the foregoing criteria and will be assessed against the Supplementary Guidance Policy for Aquaculture. All proposals will be assessed against the Shetland Islands Marine Spatial Plan that sets out a spatial strategy and policy framework to guide marine developments in the coastal waters around Shetland. The Marine Spatial Plan identifies the constraints developers are required to consider when contemplating development in the coastal area and will form supplementary guidance to this plan.	Policy screened for consideration in AEE	Chapter 10

Appendix 10.2 Baseline

APPENDIX 10.2 MARINE AND TRANSBOUNDARY EFFECTS – BASELINE CONDITIONS

Environmental Zone of Influence

The sections below characterise the water quality, biodiversity and human receptors with likely presence in the Environmental Zone of Influence (EZI; Drawings 10.1 and 10.5), based on a review of available published and unpublished literature, alongside resources from advisors and regulators. Due to the nature of Orbex PRIME orbital and sub-orbital launches, two EZIs have been identified relating to the different stages of the Orbex PRIME Launch Vehicle. The 'North Atlantic EZI' represents the environmental study area for the return of the first stage to Earth (or in the unlikely event of the flight termination system being triggered, the entirety of the Orbex PRIME Launch Vehicle including the second stage and the payload fairing); whereas the 'South Pacific EZI' represents the environmental study area for the return of the second stage to Earth.

Baseline characterisation is focused more heavily on the North Atlantic EZI, as this is the zone in which the greatest volume of debris is likely to impact, and it covers a smaller total area, therefore the impacts are predicted to be less dispersed.

Comprehensive lists of the ornithological, marine mammal, and commercial fish receptors across both EZIs are presented in Appendix 10.6.

Water Quality

Contaminants

Contaminants are chemical substances that are atypically found in the marine environment and have the potential to cause harm to marine life. Contaminants can be either anthropogenic or natural in origin. ICES (2003) describes four main groups of contaminants:

- Trace metals: heavy metals such as cadmium and mercury, from metallurgic industries, and copper, from anti-foulant;
- Organic compounds: from agricultural run-off;
- Oil: from marine activities and hydrocarbon extraction;
- Radioactive elements: from nuclear operations.

Oil pollution in the North Atlantic EZI is likely to be lower than other marine regions due to the low overall level of development and anthropogenic presence. The small amounts of exploration and drilling of oil in the Arctic has so far been limited to Russia, North America, west Greenland, and Norway (NPC, 2015). Within the North Atlantic EZI, none of these are associated with the fairings/first stage (NPC, 2015). The Arctic has received significant interest from the petroleum industry, and it is possible that exploration will become more widespread in the future. Marine traffic in the North Atlantic EZI typically decreases with distance from the coast, though there is an offshore convergence zone of traffic routes between Norway and Iceland (see Section 10.5). Though there have no doubt been occurrences of hydrocarbons entering the water from vessels, there had not been a major oil spill in the Arctic until June 2020 when one occurred from an energy plant in eastern Russia (though this is significantly outwith the North Atlantic EZI). The baseline level of hydrocarbons in the North Atlantic EZI is considered to be very low.

OSPAR have assessed the level of contaminants across different parts of the OSPAR maritime area as part of their 2017 Intermediate Assessment (OSPAR, 2017). The level of polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in shellfish and sediments in the Northern North Sea (overlapping the southern extent of the North Atlantic EZI) is below levels likely to harm marine species. The level of polybrominated diphenyl ethers (PBDEs) in shellfish and sediment in the northern North Sea is decreasing annually. Heavy metal (mercury Hg; cadmium Cd; and lead, Pb) concentrations in the fish and shellfish and sediments of the Northern North Sea are above background levels, but most are below the level at which effects would occur (with the exception of lead in sediments which are above levels where adverse ecological effects cannot be ruled out). Note that the Northern North Sea has potentially the highest level of anthropogenic pressure in the North Atlantic EZI as it is more proximate to land where anthropogenic sources of contaminants are higher.

In comparison to the North Sea, the Arctic is relatively unpolluted. Based on the OSPAR Commission Quality Status Report 2010, the Arctic (Region 1) has the lowest percentages of monitoring sites that have unacceptable levels of cadmium, mercury, lead, PAHs, and PCBs, out of all OSPAR regions (OSPAR, 2010). Of these, PAHs and PCBs are present in unacceptable levels in the highest percentages of sites (~30%), whereas for the heavy metals this is typically <10%. The monitoring sites included are restricted to coastal waters and so represent the worst-case scenario for pollutants as they are closer to the anthropogenic sources. It is likely that levels of pollutants offshore are lower than that reported at the coast. The release of most contaminants is controlled by legislative measures that aim to cease their production, and as a result there has been a general decrease in the number of pollutants in the Arctic which is predicted to continue.

There has been a historic decrease in the concentration of most anthropogenic radionuclides in the Eurasian Arctic (Josefsson, 1998). Concentration of radionuclides decreases with depth in the water column. The concentrations in the sediments of the deep Arctic Ocean are much lower than the concentrations on the shelf, primarily due to the low particle flux in the open ocean (Josefsson, 1998). There are no nuclear facilities in the North Atlantic EZI (OSPAR, 2016), therefore input of radionuclides is limited to transport from distant sources and global fallout. In summary there are likely to be negligible concentrations of radionuclides in the North Atlantic EZI.

Microplastics

Microplastics, described as plastic particles or fragments less than 5 mm in length (NOAA, 2020a), are present in most marine systems around the world (Barceló and Picó, 2019). Although the Arctic is remote and difficult to study, there has been an increase in the focus on plastic pollution in this region. Microplastics have been found both in the water and the marine organisms such as fish in the Arctic, with the most common types being polyethylene and polyester (Morgana *et al.,* 2018). The concentration of microplastics is greater than most seas at lower latitude, indicating that the Arctic is a hotspot for plastic pollution (e.g., Obbard *et al.,* 2014). Plastic pollution can originate from local sources such as vessel discharge or more distant sources, which enter the region via sea surface and sub-surface currents. Given the comparatively few direct sources in the region, it is likely that most microplastics originate outside the Arctic. The amount of microplastics in the Arctic is predicted to increase in the coming years, due to the increase in anthropogenic presence and pressure as climate change increases accessibility to the region.

Biodiversity

Physical features

The physical features of the marine environment directly influence the biodiversity found in the surrounding waters. The North Atlantic EZI comprises predominantly deep waters up to ~4,000 m below relative sea level with some shallower areas adjacent to nearby land masses including Iceland, Faroe Islands and Jan Mayen (Figure A10.1). The area is characterised by bathymetric features including plateaus, basins, rises, and ridges, including segments of the Mid-Atlantic Ridge (Figure A10.2).

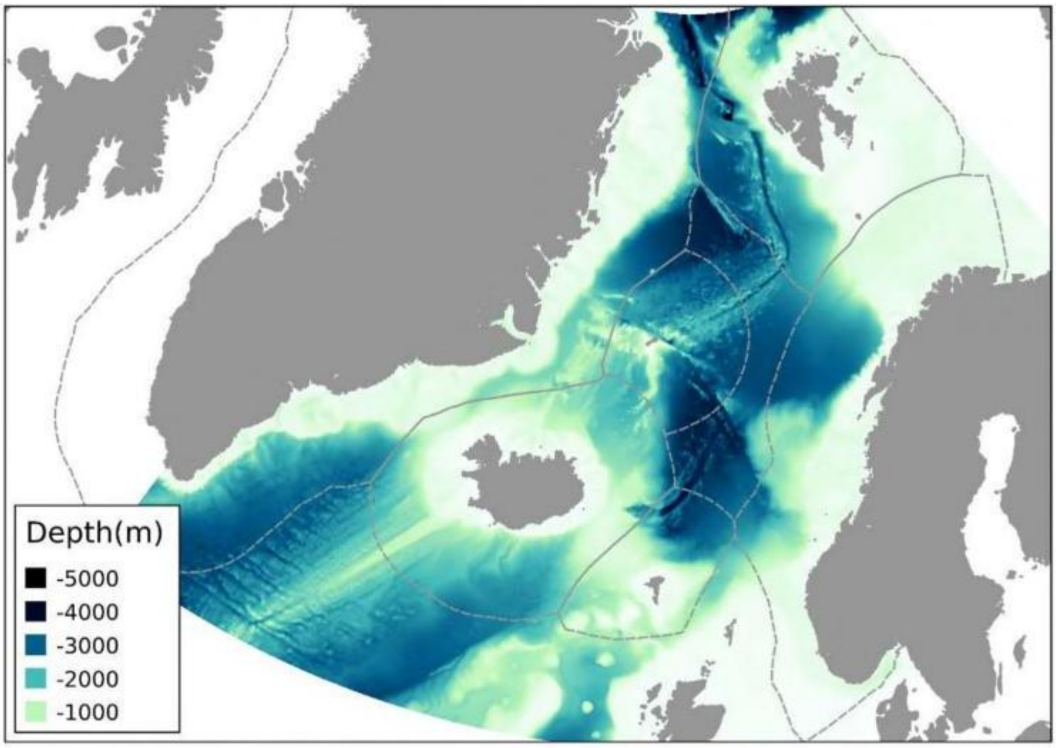


Figure A10.1 Water depth in the north-east Atlantic and Arctic regions (From: Buhl-Mortensen et al., 2019)

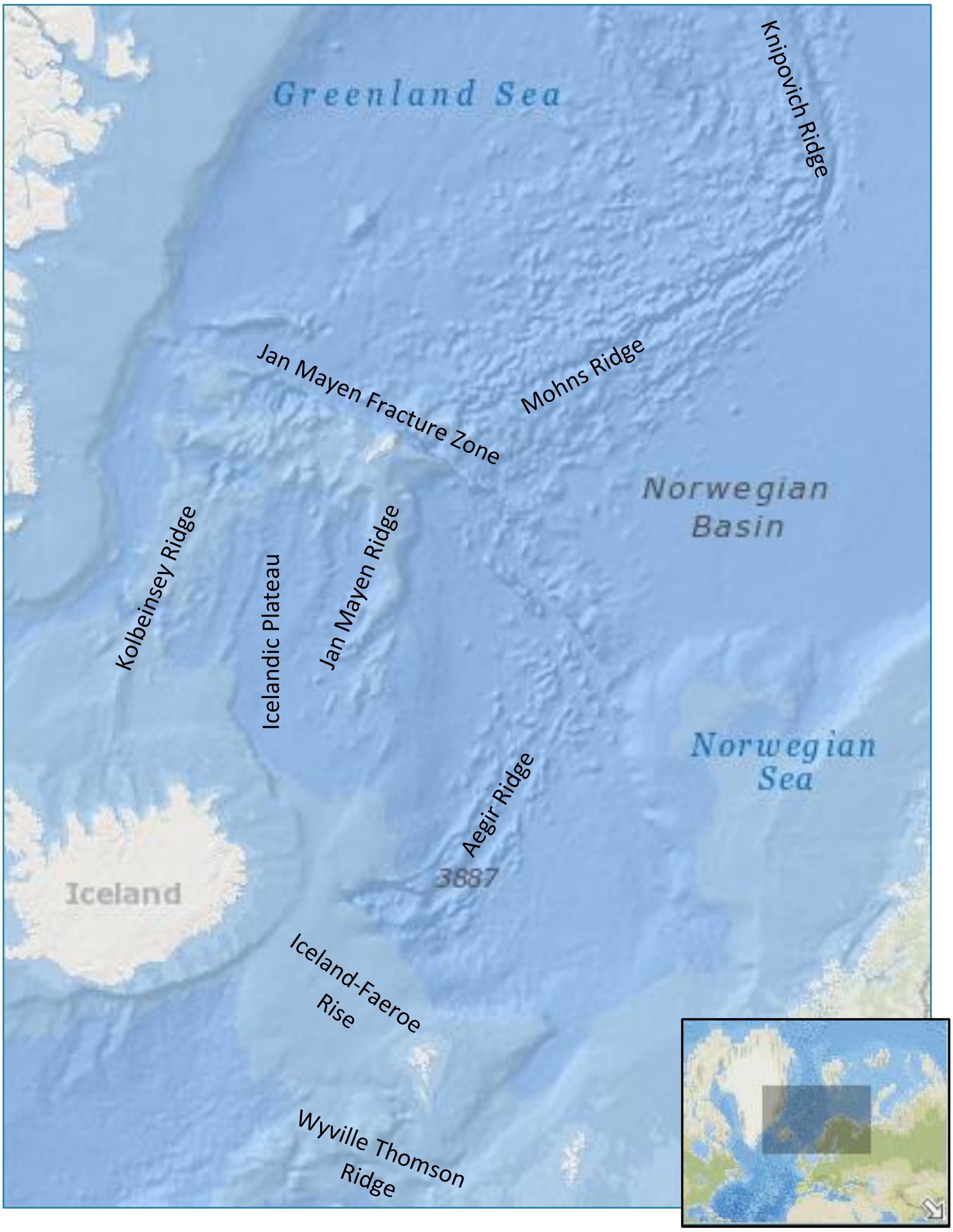


Figure A10.2 Bathymetry and bathymetric features in the vicinity of the EZI (Source: NOAA, 2020b)

Surface sea currents in the North Atlantic EZI comprise a mix of warm currents and cold currents (ICES, 2003). Travelling in a north-east direction, the North Atlantic Drift traverses between the UK and the Faroe Islands, through the Norwegian Sea and continues to the Arctic. Offshoots of this current travel between the Faroe Islands and Norway, south into the North Sea, and also circulate anti-clockwise from the Norwegian Sea towards Jan Mayen. Cold currents travel in a south/southwesterly direction from the Arctic; the East Greenland Current travels down the east coast of Greenland, with offshoots circulating clockwise towards Jan Mayen and north of Iceland (East Icelandic Current). The centre of the North

Atlantic EZI comprises a convergence of cold and warm surface currents, resulting in gyres such as the Icelandic Gyre and Greenland Sea Gyre.

The highest annual mean sea surface temperature (SST) in the region is approximately 9-10°C, in the south and southeast of the North Atlantic EZI (NOAA, 2020c), as these waters are most influenced by the warm surface waters. Influence of the Arctic-derived sea surface currents in the north and west of the North Atlantic EZI lead to minimum annual mean SST of 0-3°C. The temperature is typically 2-3° below and above average in the winter and summer, respectively (NOAA, 2020c). Temperature at the sea-bottom is -1°C throughout much of the offshore waters of the North Atlantic EZI (Buhl-Mortensen *et al.,* 2019). Warmer sea-bottom temperatures of 6.8-9.4°C are present across the areas of continental shelf that extend around the Faroe Islands and north of Shetland (Buhl-Mortensen *et al.,* 2019). Annual salinity in the North Atlantic EZI is 35-36 with minimal seasonal variation (NOAA, 2020d).

The seabed sediments in waters beyond the continental shelf, which comprises the majority of the North Atlantic EZI, are characterised as A6.5 Deep-sea mud (EMODnet, 2019). The seabed sediments in the areas beyond national jurisdiction are described on EMODnet as A.6 Deep-sea bed with no further information on the sediments themselves. Other seabed sediments that are present on the continental shelf adjacent to the Faroe Islands include A5.27 Deep circalittoral sand, A6.3 Deep-sea sand or A6.4 Deep-sea muddy sand, and A5.45 Deep circalittoral mixed sediment. A similar range of deep-sea sediments are also present on the continental shelf that extends north of Shetland, with the addition of A5.15 Deep circalittoral coarse sediment. Within the North Pacific Ocean, the North Atlantic EZI falls mostly across the abyssal plain, with soft sediments dominant.

The EZI of the second stage impact, in the South Pacific Ocean, is primarily characterised by deep basins, oceanic ridge systems and a prominent subtropical gyre. The South Pacific Ocean features a variety of sediment types, including diatomaceous sediments, carbonate-rich sediments, brown clays, mixed diatom-carbonate sediments, and diatomaceous clays. The distribution of these sediments is influenced by factors such as biological productivity, hydrography, carbonate dissolution below certain depths, and submarine volcanism (Lamy *et al.*, 2015). Hard substrata are rare, and limited to volcanic areas such as ridges, seamounts, and volcanic islands (McMurtry, 2001).

Plankton

Plankton, comprising bacteria, Archaea, phytoplankton, protists and zooplankton, form the base of the food web in cold waters such as the North Atlantic EZI and so are extremely important to the ecosystem as a whole (CAFF, 2017). Despite this, the plankton community in this region is poorly known. A summary of the knowledge of plankton in Arctic waters, which encompasses the majority of waters in the North Atlantic EZI, is provided in CAFF's (2017) State of the Arctic Marine Biodiversity Report. Monitoring of plankton in the Arctic has been most frequent in the waters of Jan Mayen, Iceland, and Greenland.

Phytoplankton are the only primary producers in cold waters such as the North Atlantic EZI and so form the base of the food web (CAFF, 2017). The Atlantic Arctic comprises the highest diversity of phytoplankton of all Arctic regions, as it contains a mixture of Arctic and North Atlantic species (CAFF, 2017). Dinoflagellates and diatoms are the most common functional groups (as found by microscopy) in the Atlantic Arctic (CAFF, 2017). Phytoplankton and other single-celled plankton are the main food for larger zooplankton such as copepods.

The zooplankton community comprises single and multi-celled organisms and is highly diverse in the Arctic, with over 350 species recorded (CAFF, 2017). Multicellular zooplankton include a wide range of invertebrates and larvae of other marine organisms such as fish (CAFF, 2017). Their longer life spans have led to the development of strategies, such as vertical migrations on daily and seasonal cycles, and preferred depth niches (CAFF, 2017). Copepods are the most abundant and well-studied species group of zooplankton, accounting for 80-90% of zooplankton biomass in the Arctic (CAFF, 2017). Copepods are highly diverse as over 150 species have been recorded in Arctic waters (CAFF, 2017). The copepod *Calanus finmarchicus* is the most common copepod species in sub-Arctic waters (CAFF, 2017). Copepods and other zooplankton such as hyperiid amphipods and euphausiids, are important prey items for other marine species including fish, seabirds, and baleen whales.

Plankton are strongly affected by environmental conditions such as water depth, current patterns, salinity, and temperature. The cyclic variation of these environmental factors leads to a predictable series of seasonal blooms by different components of the plankton community. Phytoplankton bloom in the spring, followed by an increase in zooplankton that extends through to summer and is closely linked to availability of food as well as warmer temperatures.

Benthic Species and Habitats

Benthic invertebrates are an important part of the food web and form part of the diet of fish, marine mammals, and seabirds (CAFF, 2017). Despite their importance, they remain relatively poorly understood. In the Arctic, monitoring has been focussed on macro and mega-benthic species (species >1 mm and species identifiable through imagery techniques, respectively), with comparatively less monitoring effort on meiofauna (0.1-1.0 mm) and microfauna (<0.1 mm) (CAFF, 2017). There has been an increase in benthic monitoring around Iceland, Greenland and the Norwegian Sea, though many Arctic areas remain poorly understood.

The benthos is influenced by a variety of environmental factors including water depth, currents, temperature, food availability, and seabed sediments. The degree to which these environmental factors influence the benthos depends on their life strategies. For example, benthic fauna can be mobile or sessile, with sessile organisms more heavily influenced by local environmental conditions than mobile species which can move to areas of suitable habitat. Similarly, relative influence of conditions will vary by the species' position in relation to the sediment i.e. in the sediment (infauna), on the sediment (epifauna), or just above the sediment (hyperbenthos).

Over 4,000 benthic species have been recorded in Arctic waters, accounting for the majority of marine diversity in the Arctic (CAFF, 2017). The most numerous species group in the Arctic, including the North Atlantic EZI, is arthropods (Figure A10.3). Other species of high richness in the several Arctic regions that overlap the EZI (Iceland, Faroe Islands, Norway West, and Greenland) are polychaetes and molluscs. Beyond these top three groups there are localised differences between the regions: in the Faroe Islands and Greenland foraminifera are the fourth most rich species; this position is held by echinoderms in Norway West; and in Iceland there are several different groups, including 'other', which contribute notable percentages of the total species richness. The total number of species in these regions range from 1,807-2,345.

There is a paucity of trawl stations in the offshore waters of the North Atlantic EZI in comparison to other regions of the Arctic. Nevertheless, results show that typically fewer than 20 benthic megafaunal species/taxa have been recorded at each trawl station in the EZI, which is low compared to other regions of the Arctic (CAFF, 2017).

Within the South Pacific EZI, hard substrates are typically dominated by suspension feeders, while soft sediments are dominated by deposit feeders. The South Pacific Gyre has slow accumulating sediment, and although it is the largest oceanic province, it has a lower mean biomass than other areas (D'Hondt *et al*., 2009). Metazoan megafauna consists largely of urchins, holothurians, arthropods, molluscs, and sponges (Nomaki et al., 2021). Meiofauna are dominated by nematodes (Danovaro *et al*., 2002).

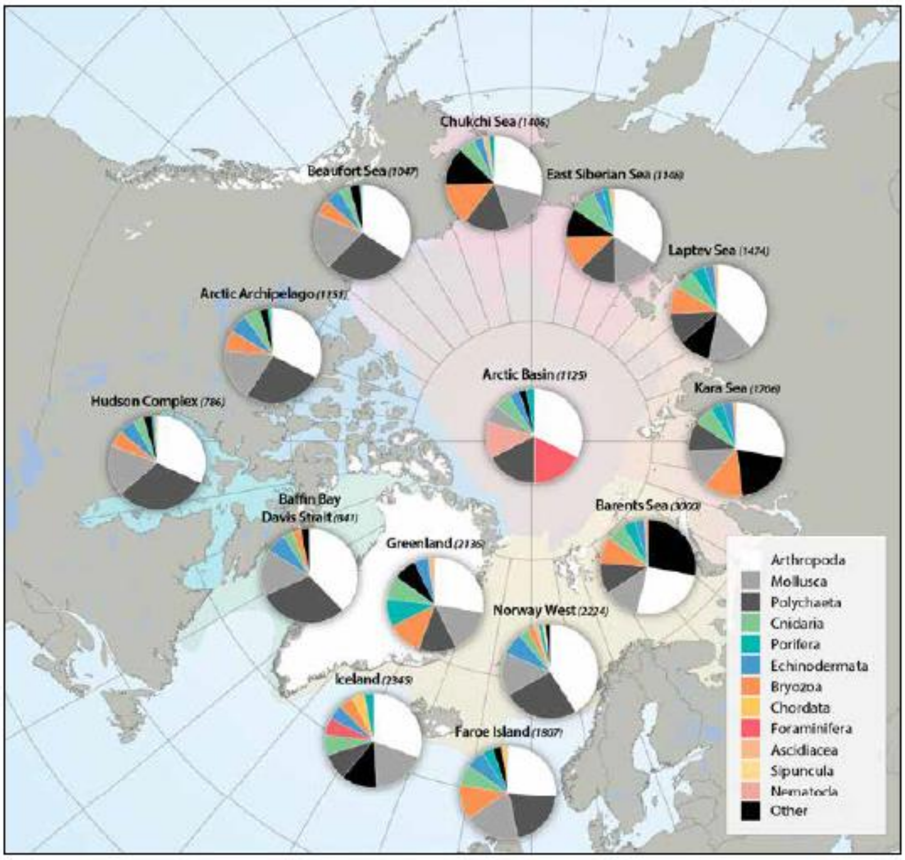


Figure A10.3 Regional pie charts showing the species/taxon number (in brackets) per region and the relative proportion of certain taxa in species richness (From: CAFF, 2017)

Certain benthic habitats, created by habitat-forming species, are especially sensitive to anthropogenic effects; these are known as Vulnerable Marine Ecosystems (VMEs). The FAO define VMEs as those areas that may be vulnerable to impacts from fishing activities (Buhl-Mortensen et al., 2019), though for the purpose of this study this definition is extended to include any anthropogenic activity that may interact with the seabed, which includes the proposed operations.

There are seven VME habitat types listed by the North East Atlantic Fisheries Commission (NEAFC): cold-water coral reef; coral garden; deep-sea sponge aggregations; sea pen fields; tube-dwelling anemone patches; mud- and sand-emergent fauna; and bryozoan patches (FAO, 2020a). As shown in Figure A10.4, there are records of VMEs in the North Atlantic EZI, though comparatively fewer than the numbers recorded around the coast of Iceland, Norway, and the Faroe Islands (Buhl-Mortensen et al., 2019). The distribution of records is likely to be compounded by the amount of survey effort in each area. To overcome this, Buhl-Mortensen et al. (2019) modelled the predicted suitability of habitats throughout the Arctic and sub-Arctic for VMEs. The results of the modelling showed that the number of VMEs is negatively correlated with water depth and positively correlated with water temperature at the sea-bottom. The majority of the North Atlantic EZI is not predicted to provide conditions for VMEs, except for localised areas around the Faroes and the Faroe-Shetland belt.

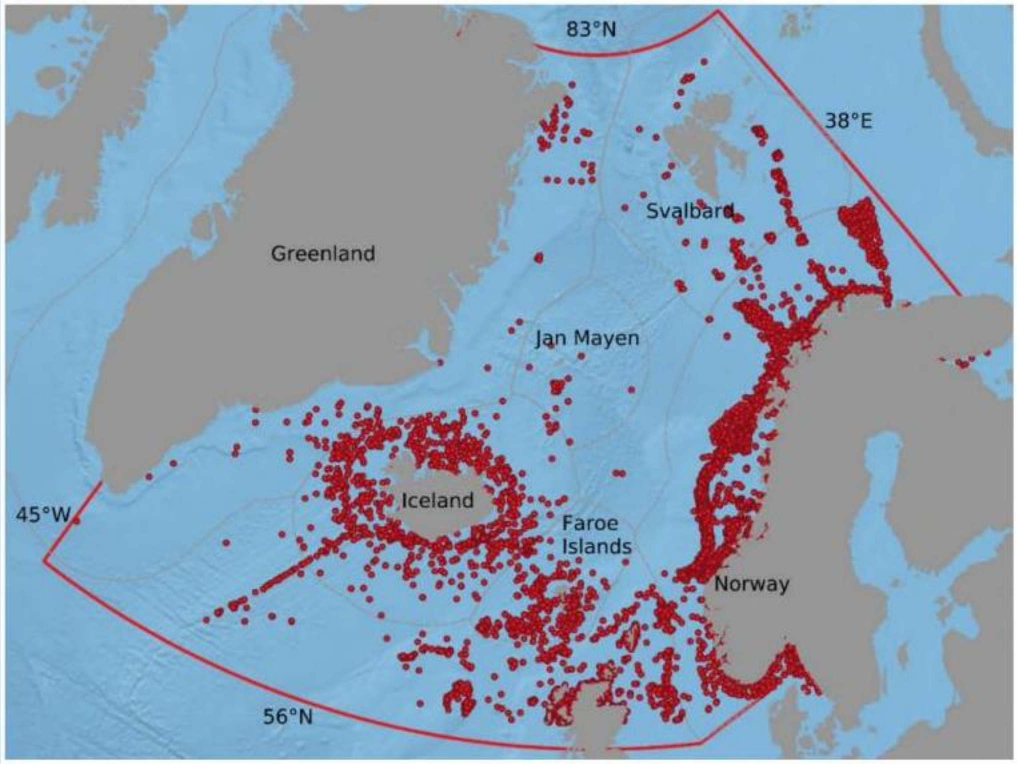


Figure A10.4 The location of Vulnerable Marine Ecosystem (VME) records in the north-east Atlantic (From: Buhl-Mortensen et al., 2019)

Fish

The Arctic waters of the North Atlantic EZI are highly productive and support a diverse fish community. A total of 633 species of marine fish have been recorded in the Arctic Ocean and adjacent seas (CAFF, 2017). Approximately 10% of these species are targeted commercially and so are subjected to stock assessments and are well-understood. Due to the lack of knowledge on the remaining 90%, this discussion focuses on the commercially important stocks.

According to OSPAR (2020), the Arctic waters support six fish species of major commercial importance: Atlantic cod *Gadus morhua*, saithe/pollock *Pollachius virens*, haddock *Melanogrammus aeglefinus*, blue whiting *Micromesistius poutassou*, Atlantic herring *Clupea harengus*, and capelin *Mallotus villosus*. The analysis of commercial fisheries data from ICES presented in this section indicates that Atlantic mackerel *Scomber scombrus* are also of commercial importance.

Atlantic cod, saithe, haddock, and blue whiting are benthopelagic, feeding at or near the seabed, whereas Atlantic herring and capelin are pelagic mid-water column fish.

An overview of the distribution of these species and their spawning activity is presented in Table A10.1. Spawning grounds are not prevalent in the North Atlantic EZI due to its offshore location away from most coastal areas where spawning occurs. The exception are saithe and blue whiting which spawn offshore over deep waters. There may be minor overlap with spawning grounds at the southern extent of the North Atlantic EZI due to overlap with the Northern North Sea. The key spawning period for most fish species is spring, though some Atlantic herring stocks in the North Atlantic EZI also spawn in autumn and summer.

A list of the major commercial fish species within the North Atlantic and South Pacific EZIs is presented in Appendix 10.6.

Table A10.1 Overview of the key commercial fish species in the North Atlantic EZI (From: Johnson, 1977; Holste and Slotte, 1995; Jakobsson and Stefansson, 1999; Dickey-Collas* et al., *2010; ICES, 2005; FishSource, 2019; FAO, 2020b)

Species	Spatial Distribution In The EZI	Spawning Activity
Atlantic cod *Gadus morhua*	Atlantic cod is present in discrete stocks around Norway, the Faroe Islands, Iceland, and the North Sea.	Spawning typically occurs in discrete areas near the coasts of the country within the stock's home range, except for the North Sea where spawning activity is widespread. Spawning occurs from January to April.
Saithe/pollock *Pollachius virens*	Saithe are widespread in the north-east Atlantic. They occur in three separate stock areas: Icelandic, Faroese, and Continental.	Saithe spawn offshore, have nursery grounds in coastal waters, then migrate offshore as adults. They have spawning areas in the Norwegian Sea. Spawning occurs between January-March.
Haddock *Melanogrammus aeglefinus*	Haddock stocks are present around Iceland, Faroe Islands and North Sea.	Key spawning grounds are along Iceland, Norway and Shetland coasts, mostly outside of the North Atlantic EZI. Peak spawning occurs in March-April.
Blue whiting *Micromesistius poutassou*	Blue whiting occurs in a single stock widespread in the north-east Atlantic.	Spawning in north-east Atlantic occurs in deep water along the Faroe-Shetland channel. Spawning occurs in in spring.
Atlantic herring *Clupea harengus*	The EZI overlaps considerably with the large north-east Atlantic/Norwegian stock of herring, as well as small distinct stocks around Iceland and the North Sea.	These stocks spawn along the coast (of Norway, Iceland, and southern Shetland), outside of the North Atlantic EZI. Spawning occurs during autumn for the North Sea stock, in summer for the Icelandic stock, and in spring for the north-east Atlantic stock.
Capelin *Mallotus villosus*	The capelin stock that occurs in the EZI occurs in the waters between Jan Mayen and Iceland.	Spawning grounds occur off southern Iceland, outside the North Atlantic EZI. Spawning occurs in spring.
Atlantic mackerel *Scomber scombrus*	Atlantic mackerel occurs as a single stock throughout north-east Atlantic waters and are widespread.	Spawning occurs in summer in warmer waters to the south of the North Atlantic EZI (though there is minor overlap with low density spawning at the southern limit of the North Atlantic EZI i.e. the Northern North Sea).

Marine Ornithology

The cold northern regions of the North Atlantic are highly productive and support large numbers of breeding and visiting seabirds.

The North Atlantic EZI overlaps ICES region E1 (Barents and Norwegian Seas), which has a seabird community comprising 69% auks, 18% gulls, 10% petrels, and ≤2% eiders, terns and Pelecaniformes (Barrett *et al.,* 2006). There is not a single estimate for the number of species that may occur in the North Atlantic EZI. In Jan Mayen, over 98 bird species have been recorded (Gabrielsen and Strøm, 2004); 64 seabird species are recognised as part of the Arctic ecosystem (CAFF, 2017); and approximately 60 seabird species have been recorded in the Faroe Islands. It is clear that the North Atlantic EZI supports a highly diverse seabird community.

There are approximately 7.4 million breeding pairs, and 25.5 million seabirds total, in region E1 (Barrett *et al.,* 2006). Of the breeding birds, approximately 70% are auk species. The Faroe Islands, which lie adjacent to the study area, have recorded at least 21 species of seabird are reported to breed (Visit Faroe Islands, 2020). The most abundant breeding seabirds are northern fulmar *Fulmarus glacialis*, European storm-petrel *Hydrobates pelagicus*, Atlantic puffin *Fratercula arctica*, black-legged kittiwake *Rissa tridactyla*, and common guillemot *Uria aalge*. On Jan Mayen, 27 birds have been reported to breed, most of which are related to the marine environment (Gabrielsen and Strøm, 2004). The most common breeding species here are northern fulmar, black-legged kittiwake, Brünnich's guillemot *Uria lomvia*, and little auk *Alle alle*. Skov *et al*. (1995) reported that the most common seabirds during summer in the southern portion of the North Atlantic EZI was northern fulmar and Atlantic puffin.

Table A10.2 provides an overview of the seabird species groups that are likely to be present within the North Atlantic EZI, detailing example species, their distribution and feeding ecology. From the available data it is apparent that there is the potential for multiple species to be present in the North Atlantic EZI at all times of the year, either on a resident, breeding, wintering or migratory basis. The numbers of seabirds present will vary seasonally and also across different locations in the North Atlantic EZI.

Seabird species establish nests and rear chicks on land, therefore there are only a few locations in the North Atlantic EZI where breeding may occur. Some species breed throughout all land-based locations in the North Atlantic EZI and may be seen in the region most of the year-round. Other species' breeding is limited to the Arctic, in the northern part of the North Atlantic EZI, however these species may be seen at-sea in the southern part of the North Atlantic EZI during winter. Most seabird species breed on the sea cliffs, though some also use areas further inland such as heathlands (Visit Faroe Islands, 2020). The breeding season for seabirds runs from May through September (Visit Faroe Islands, 2020), and so during this summer period seabirds are present in the highest numbers. During the breeding season seabirds will undertake at-sea foraging trips whilst at the colony. The distances to which they forage varies greatly between species, from 25 km for great cormorant to up to several hundreds of kilometres for northern gannet and northern fulmar (Woodward *et al.,* 2019).

The distribution of seabirds outside the breeding season is comparatively less well-known. It is hypothesised that seabird abundance in winter is linked to areas of high productivity, such as the waters southwest of Greenland, which is used by seabirds from both European and North American colonies (Boertmann *et al.,* 2004; Fredericksen *et al.,* 2012).

The SEATRACK project presents tracking data of seabirds from northwest Europe colonies during the non-breeding season (autumn through spring, August to April) from 2009-2019 (SEAPOP, 2020). Seabird distribution during the winter varies greatly depending on the species' strategy. Species including Atlantic puffin, black-legged kittiwake, common guillemot, and northern fulmar are widely distributed in the North Atlantic EZI during the non-breeding season. Brünnich's guillemot and little auk distribution is restricted to the northerly portion, bounded to the south by Iceland. Some species like common eider, European shag, glaucous gull herring gull remain close to their breeding colonies year-round. Lesser black-backed gull is concentrated around their breeding colonies but also have significant hotspots along southerly migration corridors to the equator.

The seabird community is diverse in form, comprising species that occupy a range of feeding niches, including surface-feeders like the gulls, sub-surface divers like auks, gannets and divers, and bottom feeders such as sea ducks (Barrett *et al.,* 2006; CAFF, 2017). Many seabirds feed exclusively in the marine environment, however, some also opportunistically scavenge or feed off the land, such as gulls and geese.

A list of ornithological receptors within the North Atlantic and South Pacific EZIs is presented in Appendix 10.6.

Table A10.2 Seabird groups, representative species with likely presence in the North Atlantic EZI and their autecology (From: Virtual Hebrides, 2014; CAFF, 2017; Oceanwide Expeditions, 2020; RSPB, 2020; Visit Faroe Islands, 2020)

Species Group	Representative Species	Spatiotemporal Distribution In The EZI	Feeding Ecology
Gaviformes	Great northern diver *Gavia immer*, red-throated diver *G. stellata*	Summers in Scotland and Iceland, which coincides with their breeding season (April-May). Great northern diver breeds in more northerly latitudes than red-throated diver. Once summer has passed, they move to warm waters further south. During the breeding season divers occupy sheltered water bodies, whereas outside the breeding season they spend time at sea.	Undertakes dives, up to 60 m in depth (for the great northern diver), to catch fish and crustaceans.
Sea ducks	Long-tailed duck *Clangula hyemalis*, common eider *Somateria mollissima*, velvet scoter *Melanitta fusca*, red-breasted merganser *Mergus serrator*	Some species of sea duck, like common eider and red-breasted merganser, breed in the North Atlantic EZI. Others, like the long-tailed duck and velvet scoter, do not as they breed along Arctic coasts. Those species that breed in the North Atlantic EZI do not typically reside there in winter, whereas the long-tailed duck and velvet scoter can be found in Iceland and Britain in winter.	Sea ducks dive to locate prey, taking aquatic invertebrates, fish, and plant matter. The extent of their diving nature varies; the best diver is the long-tailed duck, which can dive to 60 m.
Geese	Pink-footed goose *Anser brachyrhynchus*, barnacle goose *Branta leucopsis*, brent goose *B. bernicla*	These geese species typically breed in the northern part of the North Atlantic EZI such as Iceland, though barnacle geese have a small breeding population in the UK (south of the North Atlantic EZI). They are more common in the southern part of the EZI whilst migrating and during winter.	Geese feed off the land, eating grain, winter cereals, potatoes and grass
Pelecaniformes	Great cormorant *Phalacrocorax carbo*, European shag *P. aristotelis*, northern gannet *Morus bassanus*	European shag, great cormorant and gannets have been known to breed at coastal sites in the North Atlantic EZI, as well as having presence in other seasons in lower numbers	Pelecaniformes are piscivores and are well-adapted to visual hunting of fish. Shags and cormorants hunt in shallower waters as they target prey at the seabed, whereas gannets hunt shoaling fish near the surface

Species Group	Representative Species	Spatiotemporal Distribution In The EZI	Feeding Ecology
Petrels	Northern fulmar *Fulmarus glacialis*, Arctic skua *Stercorarius parasiticus*, great skua *Stercorarius skua*, Manx shearwater *Puffinus puffinus*, European storm-petrel *Hydrobates pelagicus*	The skuas, Manx shearwater and European storm-petrel visit the North Atlantic EZI during the warmer months; they breed here in summer and can also been seen in spring and autumn. Fulmar also breed here though they can be seen year-round in the North Atlantic EZI	Skuas are parasitic feeders in that they steal food from other seabirds, as well as scavenging off dead animals. Fulmars are opportunistic feeders, taking fish and invertebrates but also rubbish and carrion. Manx shearwater and European storm-petrel feed on small fish and invertebrates, and offal at the surface
Gulls	Black-legged kittiwake *Rissa tridactyla*, common gull *Larus canus*, herring gull *Larus argentatus*, glaucous-winged gull *Larus glaucescens*, glaucous gull *Larus hyperboreus*, great black-backed gull *Larus marinus*, lesser black-backed gull *Larus fuscus*, ivory gull *Pagophila eburnea*, black-headed gull *Chroicocephalus ridibundus*	Most gull species can be seen year-round in the North Atlantic EZIs, although some may be absent in winter. Many species breed in the North Atlantic EZI, such as black-legged kittiwake, great black-backed gull, and glaucous gull, and so are more numerous in the warmer months. Iceland gull and glaucous gull are predominantly winter visitors.	Kittiwakes are exclusive marine feeders in that they eat small fish or the remains of fish, caught at the sea surface. Other gull species will also take land-based prey, carrion and rubbish, with less importance on marine prey
Terns	Arctic tern *Sterna paradisea*, common tern *Sterna hirundo*	Arctic tern is a common breeder in the North Atlantic EZI, and common tern breeds in low numbers on Shetland. Both species can be found in the warmer summer months, following which they migrate south in winter	Terns predominantly get their food from marine sources, eating small fish and pelagic invertebrates. They visually scan the sea for food at or just beneath the surface
Auks	Atlantic puffin *Fratercula arctica*, little auk *Alle alle*, common guillemot *Uria aalge*, Brünnich's guillemot *Uria lomvia*, black guillemot *Cepphus grylle*, razorbill *Alca torda*	Auks are the most abundant and the most abundantly breeding seabird species group in the North Atlantic EZI. Outside the breeding season auks are scarcer. Some species like Brünnich's guillemot and little auk only breed in the northern region of the first stage EZI, and winter at sea in the southern portion.	Auk species feed on fish and crustaceans. Auks are characterised by their short wings which they use to propel themselves on whilst diving for food

Marine Megafauna

A number of marine mammal species (cetaceans, including whales, dolphins and porpoises, and pinnipeds, including seals and walrus) have been recorded within the North Atlantic EZIs. Information from several sources that report on areas overlapping the North Atlantic EZI have been reviewed, including OSPAR (2020) and the North Atlantic Marine Mammal Commission (NAMMCO, 2020), a body that comprises representatives from Faroe Islands, Greenland, Iceland and Norway.

Seven species of pinniped, including six species of true seal and the walrus, are found in the waters of the Arctic, North-east Atlantic, and North Pacific. (NAMMCO, 2020; OSPAR, 2020). Harbour seal *Phoca vitulina* and grey seal *Halichoerus grypus*, are described as coastal and area also likely to be present in the North Atlantic EZI. The remaining 5 species of seal and walrus are considered to be associated with sea ice, which is not likely to interact with the first or second stages within the EZI, and are therefore not considered further.

Sixteen species of cetacean, including six species of baleen whale and 10 species of toothed whale, are common permanent residents in either the North Atlantic, North Pacific, or the Arctic Oceans and regions (NAMMCO, 2020). Of these, three species are associated with the sea ice, namely bowhead whale *Balaena mysticetus*, beluga *Delphinapterus leucas*, and narwhal *Monodon monoceros*, which is not likely to interact with the first or second stages within the EZI, and are therefore not considered further**.**

Table A10.3 provides an overview of the marine mammal species that are likely to be present within the North Atlantic EZI, detailing their distribution and feeding ecology. From the available data it is apparent that there is the potential for multiple species to be present in the North Atlantic EZI at all times of the year. The numbers of marine mammal's present will vary seasonally and across different locations in the North Atlantic EZI.

Long-finned pilot whale *Globicephala melas*, Atlantic white-sided dolphin *Lagenorhynchus acutus*, and common dolphin *Delphinus delphis*, are common across the North Atlantic EZI, accounting for 93% of the cetacean abundance observed in one summer study of the North Atlantic (Skov *et al.,* 1995). Other species of megafauna that may be present in the North Atlantic EZI include common sunfish *Mola mola* and basking shark *Cetorhinus maximus* (CMS, 2020; Ocean Sunfish, 2020). These species have been included as part of the megafauna because their behavioural trait, of often remaining just below the sea surface, is more similar to marine mammals than other fish species.

A list of ornithological receptors within the North Atlantic and South Pacific EZIs is presented in Appendix 10.6.

Table A10.3 Overview of the marine mammal species with likely presence in the North Atlantic EZI (Source: NatureScot, 2019; SCOS, 2019; NAMMCO, 2020; NBN Atlas, 2020)

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
Otarioids					
Harbour seal *Phoca vitulina*	The combined populations in Norway, Shetland and Iceland consist of approximately 23,500 individuals. The total worldwide population is approximately 610,000-640,000 individuals.	There are several distinct populations in the North Atlantic EZI; Ireland-Scotland, Faroe Islands (historical), Iceland, and West Coast Norway. They have a coastal distribution in the North Pacific (from 28 to 61.2° N), along the west coast of North America, across the Aleutian Islands, the southeast coast of Kamchatka Krai, and the Kuril Islands.	Harbour seals typically remain within 50 km of their coastal haul out sites.	Harbour seal breeding season across their range occurs from February to July, though breeding colonies will differ in their timings.	They are generalist predators, taking predominantly small to medium sized fish including cod, herring, sandeel, and flatfish.
Grey seal *Halichoerus grypus*	The combined populations in Norway, Faroe Islands, Shetland and Iceland is approximately 16,500	There are 2 distinct populations in the North Atlantic EZI; the north-east Atlantic which occurs in the waters of Scotland, Faroe Islands and Norway; and the Icelandic population.	Grey seal haul out on islands, isolated beaches or on the pack ice. From these haul out sites they undertake foraging trips which can be 1-30 days, and up to several hundred kilometres from their haul out sites	Grey seal breeding season runs from late September until February/March, with peak activity in October/November	They are generalist feeders, taking a wide variety of prey usually near the sea bottom (demersal and benthic fish)

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
Sperm whale Physeter macrocephalus	The most recent survey around Iceland/Faroes created an abundance estimate of 23,200 individuals.	Sperm whales are found throughout the world's oceans, right up to the ice edge at the poles. In the north pacific, females and young sperm whales remain generally in warmer and tropical waters year-round (above 50 °N). Females were found in Olyutorsky (62°N) in the western Bering Sea, and western Aleutian Islands. During summer, males are present in the Gulf of Alaska, Bering Sea and around the Aleutian Islands.	Sperm whales are found in the open ocean though increase in numbers around the continental shelf and seamounts. Migrations are sec-specific, with predominantly males found at higher latitudes.	Sperm whales breed and calve in the summer months in tropical waters.	Feed primarily on large squid along with demersal and mesopelagic skates, sharks, and fishes.
Humpback whale *Megaptera novaeangliae*	There are two discrete humpback whale areas in the North Atlantic EZI: the Iceland/Faroes, and Norway. Abundance in these two areas is estimated at 20,500 individuals.	Humpback whales in the north-east Atlantic are most common in Icelandic waters, with fewer sightings in offshore areas. Most humpback whales undertake extensive migrations each year,	Humpback whales are largely pelagic, though during the feeding season they occur in highly productive upwelling zones.	Mating and calving occur in the warm breeding grounds during winter. During the winter most humpbacks migrate to subtropical and tropical waters of	Feed mainly on euphausiids (krill) and small schooling fish.

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
		though some remain in the cool waters of the North Atlantic year-round. Summer feeding grounds are in the Northern Pacific, in the Beaufort Sea.		the northern and south hemispheres. In the north pacific, there's a minimum of 3 breeding populations (Hawaii, Asia, and Mexico/central America). They migrate to their respective calving grounds in the winter/spring and mating areas for summer/fall.	
Blue whale *Balaenoptera musculus*	Abundance of blue whale in the North Atlantic is low, estimated to be 2,490 in the Central North Atlantic.	The species is rare in the north-east Atlantic except for in the waters around Iceland. There have also been sightings around Jan Mayen. The species undertakes extensive migrations each year and are present in North Atlantic waters during summer months only, for feeding. 1 stock in the North Pacific, there are more towards the	Generally, occur in offshore waters.	Very little is known of blue whale mating and calving. Calving generally occurs in the winter, whilst the species is in warm waters.	Blue whale feed almost exclusively on euphausiids (krill) and crustaceans.

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
		Gulf of Alaska, California, and eastern Aleutians. The Aleutian Pacific stock is thought to feed off California, and Alaskan waters, migrating offshore north of Hawaii in winter.			
Common minke whale *Balaenoptera acutorostrata*	Minke whales in the North Atlantic EZI comprise the north-east Atlantic stock, which has most recently been estimated as having an abundance of approximately 90,000 individuals.	The species is common in the north-east Atlantic, particularly in Icelandic waters. Like other baleen whales, common minke whale undertakes extensive migrations each year, summering in the cool North Atlantic waters that comprise their feeding areas. In the north Pacific Ocean from the Bering and Chukchi seas south, to the near equator minke whales are relatively common, along with	Generally, occur in offshore waters though occasionally recorded in productive inshore waters e.g. upwelling zones.	Calving of common minke whale generally occurs in the winter, whilst the species is in warm waters. Minkes in the Chukchi sea in august, October and November. Whales summering in the Chukchi seas might winter in the central north pacific. Minke whales occur seasonally around the Hawaii islands.	Common minke whales feed on a variety of fish and invertebrates. In Arctic waters their diet comprises mostly krill, with increasing importance of fish with distance south.

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
		inshore waters of the Gulf of Alaska, but not abundant at the east of the pacific.			
Fin whale *Balaenoptera physalus (velifera* (pacific population/species))	There are two fin whale management areas within the North Atlantic EZI: East Iceland and Faroe Islands, and North-West Norway. These two populations comprise approximately 30,500 individuals.	Fin whale is distribution through the North Atlantic with peak numbers west of Iceland. Like other baleen whales, fin whale undertakes extensive migrations each year, summering in the cool North Atlantic waters that comprise their feeding areas. The North Pacific populations occur in temperate to sun-polar latitudes. Fin whales are found seasonally off the coast of the North American coast and the Bering Sea during the summer. Very common in the Bering Sea, high distribution along the green belt.	Fin whales are largely pelagic but may occasionally be seen in coastal waters.	Mating and calving occur in the warm breeding grounds during winter.	Fin whale feed on euphausiids (krill) and small pelagic fish.

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
Sei whale *Balaenoptera borealis*	The most recent surveys indicate an abundance of ~4,000 animals in the Central North Atlantic and European Atlantic.	Sei whale distribution is poorly understood due to their offshore nature. Most sightings in summer are between Greenland and Iceland, with some in the Faroe-Shetland Channel. Scarce in UK and Norwegian waters. There are multiple populations in the North Pacific.	Sei whale prefers offshore and warmer waters than other baleen whales. They are often associated with bathymetric features like rises, due to prey abundance.	Mating and calving occur in the warm breeding grounds during winter.	The diet will vary depending on what is locally available. Preferred prey includes copepods, euphausiids (krill), other crustaceans and fish.
Atlantic white-sided dolphin *Lagenorhynchus acutus*	Likely to be a single stock across the North Atlantic. Most recent surveys indicate 130,000 animals in this region.	In the north-east Atlantic they are found in waters between East Greenland, Iceland, UK, and Norway. They are not found in the Bering Sea, North Pacific, or Beaufort Sea, as such the distribution is limited, and they are not present within the impact zone for the second stage.	They are found throughout the North Atlantic EZI, over steep areas of the continental shelf and open oceanic waters. They have a large home range that they move throughout, following seasonal movements of their prey.	Birthing occurs in the summer months, from May to August with a peak in June and July.	They have a varied diet, feeding opportunistically on schooling fish and occasionally cephalopods.

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
Common bottlenose dolphin *Tursiops truncatus* Hawaiian Island stock Common bottlenose dolphin *Tursiops truncatus truncatus*	There have been several estimates of common bottlenose dolphin abundance in the wider European Atlantic waters, ranging from 19,000-28,000.	Common bottlenose are found in waters across the Atlantic Ocean, as far north as Scotland, Faroe Islands and Norway. Common within the Hawaiian Islands, separate offshore and coastal populations, common in the eastern pacific.	Common bottlenose dolphin inhabits a wide range habitat, from inshore sheltered areas to open oceans.	Calving occurs during the warmer months, from May to October, peaking when sea temperatures are warmest.	Common bottlenose dolphin varies their diet depending on location and season. They take pelagic and demersal fish, cephalopods, and crustaceans.
Harbour porpoise *Phocoena phocoena*	An estimated 22,800 animals occur in the European waters north of the UK	Harbour porpoises are mostly associated with the coasts of Iceland, Norway, Faroe Islands, and the UK. They have been known to make seasonal movements depending on habitat and prey requirements. Regularly found in northern Japan, distinctly in waters from 10-32 °C.	Harbour porpoise is found in coastal areas, though they may sometimes be observed over deeper waters offshore.	Mating and birthing occur in summer, from May to July.	Harbour porpoise diet varies by season and location. They can take a wide variety of benthic and pelagic prey, though only take two or three species at a time.
Killer whale *Orcinus orca*	Up to 14,000 killer whales are estimated to use the waters of Iceland and Norway; these	In the north-east Atlantic, killer whale may be found off the	Killer whales can be found both inshore and offshore, in association with their prey. They undertake long-distance	Calving of killer whales is poorly understood, but it is	Killer whales are generalist feeders, taking a range of marine species,

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
	likely move within the wider north-east Atlantic	coast of Shetland, Iceland, and Norway. There is an Alaskan Resident stock, occurring in high densities on colder, productive waters. They have seasonal all year-round occurrence in Alaska (its residency) the Bering Sea and the Aleutian Islands, labelled as resident, transient, and offshore.	movements throughout their range.	thought that there is no distinct season.	though can become specialised in local areas.
Long-finned pilot whale *Globicephala melas* Hawaiian stock *Globicephala macrorhynchus*	The most recent survey centred around the Faroe Islands indicated a population abundance of 344,000	The species is widely distributed in the north-east Atlantic. They are frequently found in the waters around the Faroe Islands, though do not typically go further north than Iceland. Two populations have been identified in Japanese waters. They are common there and in the Hawaiian Islands.	The species utilises both coastal and offshore habitats. Movements coincide with movements of prey.	Breeding and mating usually takes place between April and September.	Diet primarily consists of schooling squid, small pelagic fish also taken.

Marine Mammal Species Group	**Abundance**	**Distribution**	**Habitat**	**Key Seasons**	**Prey**
Northern bottlenose whale *Hyperoodon ampullatus*	Approximately 28,000 individuals have been estimated for the North Sea, Norwegian Sea, and the waters around Iceland and the Faroe Islands	The species only occurs in the cool, northern parts of the North Atlantic. They are regularly seen in the Norwegian Sea and off the Faroe Islands. They are not found in the Bering Sea, North Pacific, or Beaufort Sea, as such the distribution is limited, and they are not present within the impact zone for the second stage.	These whales prefer deep waters seaward of the continental shelf. Migration strategies vary between individuals	The breeding of northern bottlenose whale is not well understood. Calving is thought to occur in spring to early summer	The species feeds on deep-water squid only
Risso's dolphin *Grampus griseus*	There is an estimated abundance of 11,000 individuals in the north-east Atlantic	The species prefers warmer waters of the North Atlantic, hence it is only an occasional visitor to the North Atlantic EZI. In Hawaii they are known as visitors, and most sightings within these areas occur in deeper waters offshore.	Risso's dolphin are primarily found over continental slope, outer shelf, and oceanic areas. They do not undertake migrations, but will move to follow prey distribution	Risso's dolphin calve year-round, with a peak in summer between March and July	Their diet comprises cephalopods, with variable importance of species dependent on location

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
Striped dolphin *Stenella coeruleoalba*	In the European Atlantic waters, it is estimated that there are 372,000 striped dolphins.	Striped dolphin is found in warm waters; the observations in Norway, Faroe Islands and Iceland are considered extra-limital. Common in nearshore waters with a greater depth of 3500 m, as they are infrequent to shallow waters. They have been exploited in the north pacific, and in the tropical pacific they are a single stock.	The species' distribution is linked to prey availability	Calving of striped dolphins occurs in summer or autumn	Their diet comprises mostly oceanic pelagic fish, particularly lanternfish and cod
White-beaked dolphin *Lagenorhynchus albirostris*	More than 100,000 individuals are estimated to occur in the North Atlantic Ocean	White-beaked dolphin are found in the cold waters of the North Atlantic. The species is common around Iceland, Norway, and the UK. There are no specific stocks inhabiting the Bering Sea, North Pacific, or Beaufort Sea.	The species shows a preference for water depths <200m, though it can be found both on and off the continental shelf	Both mating and calving is thought to occur in the summer months, between June and September	The species feeds mostly on fish species, but occasionally cephalopods and crustaceans too

Marine Mammal Species Group	Abundance	Distribution	Habitat	Key Seasons	Prey
Beaked whales Ziphiidae	The most recent surveys indicate that at least 14,500 individuals occur in European waters (closest extent to the North Atlantic EZI)	Beaked whales are found in all oceans of the world, though some species have restricted distribution. There are insular and offshore pelagic populations around the Hawaiian Islands. There maybe be an offshore (>2100m) population too due to no re-sightings of those individuals.	Generally found in deep waters area off continental shelves, often associated with areas of steep bathymetric relief	The reproduction of beaked whales is unknown	Beaked whales take deep water species of squid a fish, which they detect using echolocation

Marine Protected Areas

The North Atlantic EZI supports several Marine Protected Areas (MPAs) of different designations and under different jurisdictions. There are also a range of MPAs in coastal waters of the countries in the vicinity of the North Atlantic EZI, such as Iceland, Greenland, and Norway. Further details on the MPAs that have direct spatial overlap with the North Atlantic EZI are provided in Table A10.4 and the MPAs that overlap with the South Pacific EZI are presented in Drawing 10.2.

Table A10.4 Details of marine protected areas that overlap the North Atlantic EZI (Source: JNCC, 2020a; Scottish Natural Heritage, 2020)

Marine Protected Area	Designated Features / Designation Type
North Atlantic EZI	
Faroe-Shetland Sponge Belt Nature Conservation Marine Protected Area	Deep sea sponge aggregations Offshore subtidal sands and gravels Ocean quahog aggregations Continental slope Quaternary of Scotland - continental slope channels; iceberg ploughmark fields, prograding wedges Submarine Mass Movement - slide deposits Marine Geomorphology of the Scottish Deep Ocean Seabed - sand wave field, sediment wave field
North-east Faroe-Shetland Channel Nature Conservation Marine Protected Area	Deep sea sponge aggregations Offshore dee- sea muds Offshore subtidal sands and gravels Continental slope Quaternary of Scotland - prograding wedge; Submarine Mass Movement - slide deposits Marine Geomorphology of the Scottish Deep Ocean Seabed - contourite sand/silt Cenozoic Structures of the Atlantic Margin - mud diapirs
West Shetland Shelf Nature Conservation Marine Protected Area	Offshore subtidal sands and gravels
Hermaness, Saxa Vord and Valla Field Special Protection Area	Fulmar *Fulmarus glacialis*, breeding Gannet *Morus bassanus*, breeding Great skua *Stercorarius skua*, breeding Guillemot *Uria aalge*, breeding Kittiwake *Rissa tridactyla*, breeding Puffin *Fratercula arctica*, breeding Red-throated diver *Gavia stellata*, breeding Seabird assemblage, breeding Shag *Phalacrocorax aristotelis*, breeding
Fetlar Special Protection Area	Arctic skua *Stercorarius parasiticus*, breeding Arctic tern *Sterna paradisaea*, breeding Dunlin *Calidris alpina schinzii*, breeding Fulmar, breeding Great skua, breeding Red-necked phalarope *Phalaropus lobatus*, breeding Seabird assemblage, breeding Whimbrel *Numenius phaeopus*, breeding

Marine Protected Area	Designated Features / Designation Type
North Atlantic EZI	
Fetlar to Haroldswick Nature Conservation Marine Protected Area	Black guillemot *Cepphus grylle* Circalittoral sand and coarse sediment communities Horse mussel beds Kelp and seaweed communities on sublittoral sediments Maerl beds Shallow tide-swept coarse sands with burrowing bivalves Marine Geomorphology of the Scottish Shelf Seabed
Pobie Bank Reef Special Area of Conservation	Reefs
Jan Mayen Strict Nature Reserve	The whole island and up to 12 nautical miles from the coastline
South Pacific EZI	
Ailinginae Conservation Area	Live shells/ mollusks; Napoleon wrasse; Bump-head parrot fish; Giant clams; Turtles and turtle eggs; Coconut crabs; Pearl oysters; Groupers; Sharks; Live corals; Birds; Sponges; Marine mammals; Native vegetation (except coconuts and fronds); Live rock or dead coral; Beach sand; Any organism for bioprospecting: and Females lobsters with eggs and undersized juvenile lobsters
Ailuk Conservation Area	Undefined
Arno Conservation Area	Part no-take (20.92 km^2)
Bikar and Bokak Atolls	No-take
Jaluit Conservation Area	Ramsar Site
Likiep Atoll Conservation Area	All fishery resources
Mili Atoll Conservation Area	Micronesian Imperial-pigeon *Ducula oceanica* Sonneratia mangrove wetlands Seabird rookeries Reef communities
Rongelap Conservation Area	ICUN Category VI
Namdrik Conservation Area	Ramsar Site
Majuro Conservation Area	Coral reefs; Birds including bristle-thighed curlew; Sea turtles including green turtles; Fish including bumphead parrotfish.

Marine Protected Area	Designated Features / Designation Type
North Atlantic EZI	
Kwajalein Conservation Area	Seabirds; Shorebirds; Sea turtles; black noddies; white fairy terns; Large frigate-birds; Deraniyagala’s beaked whale.
Rakahanga/ Manihiki Marine Protected Area	Under development
Penrhyn Marine Protected Area	Marine Conservation Zone
Pukapuka/ Nassau Marine Protected Area	Marine Conservation Zone
Marae Moana/Cook Islands Marine Park	Under development (Marine Conservation Zone and National Marine Park Zone)
Pacific Remote Islands Marine National Monument	Marine National Monument
Baker Island National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Howland Island National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Jarvis Island National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Johnston Island National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Kingman Reef National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Palmyra Atoll National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Baker Island National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Howland Island National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Jarvis Island National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Kingman Reef National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants
Palmyra Atoll National Wildlife Refuge	National Wildlife Refuge; birds, fish, marine mammals, plants

Humans/Human Activities

Shipping and Navigation

As the North Atlantic EZI encompasses mostly open ocean, there are very few ports in the North Atlantic EZI itself. Ports are present along of the coasts of adjacent countries such as Shetland, Iceland, Faroe Islands, and Norway, though these are mostly small (Figure A10.5). The majority of the North Atlantic EZI lies within the main area of vessel traffic in the Arctic, with the waters around Jan Mayen and Greenland form part of the secondary areas of traffic (Figure A10.5). The North Atlantic EZI does not overlap any of the three main Arctic Sea transport routes (Figure A10.5). As displayed for the wider region in Figure A10.6, vessel density is highest adjacent to the coasts where there are ports (Iceland, Norway, the Faroe Islands) which is mostly outside the North Atlantic EZI. Vessel density in the North Atlantic EZI can be characterised as low.

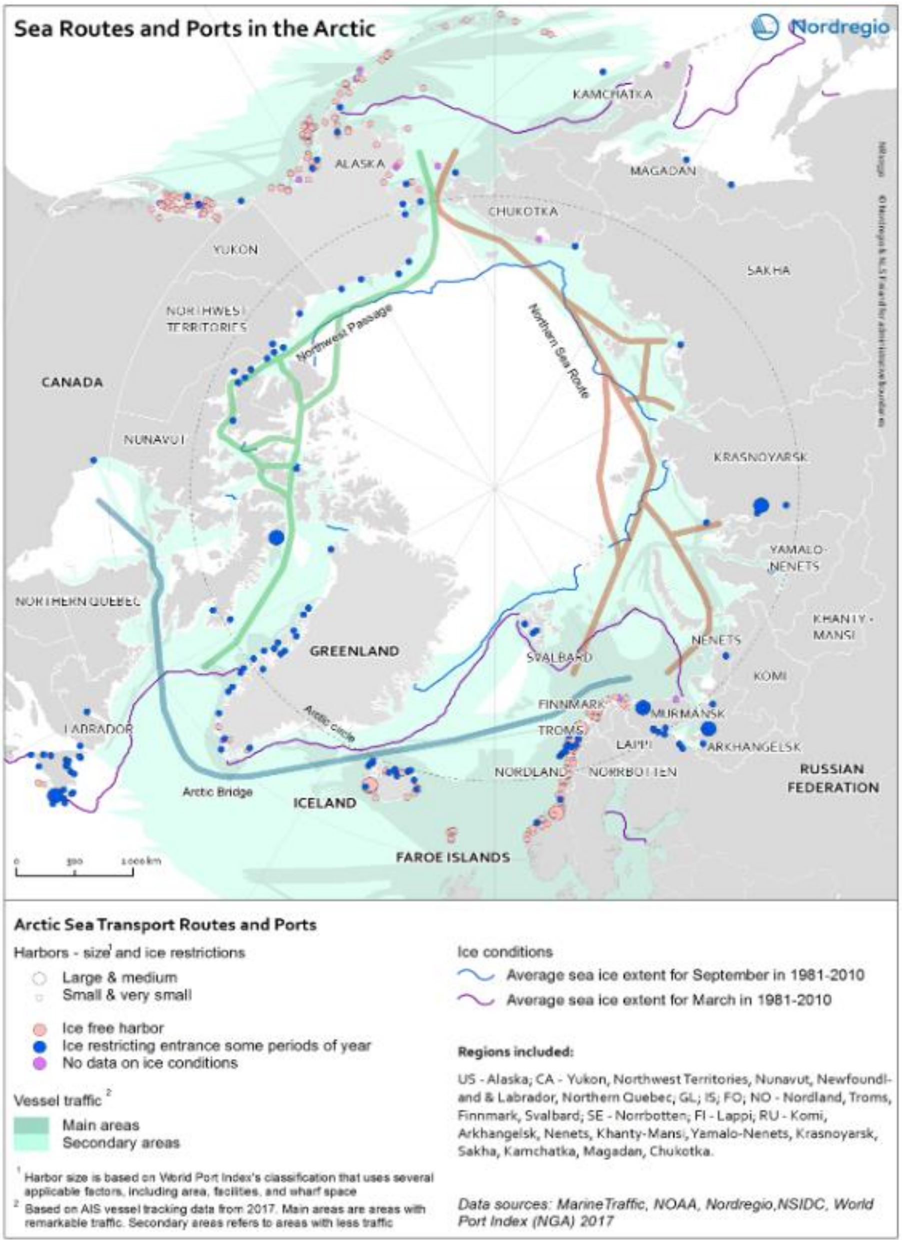


Figure A10.5 Sea routes and ports in the Arctic (From: Nordregio, 2020)

Figure A10.6 Ship traffic density in the vicinity of the North Atlantic EZI (From: EMODnet, 2020)

Oil and gas

Oil and gas infrastructure are present in high density in the UK Exclusive Economic Zone (EEZ) portion of the North Atlantic EZI, and to a lesser extent in Norwegian waters. Many boreholes have been drilled in these areas; the majority of boreholes are located within active licence areas for hydrocarbon exploration. Installations are restricted to the west of Shetland and north-east of Shetland (in UK/Norwegian waters), and these are mostly operational with some being decommissioned (EMODnet, 2020). In the waters of Jan Mayen several deep-sea boreholes were drilled in 1974, but these have not been further exploited (Orkustofnun, 2008). Drilling campaigns have also occurred in the Faroe Islands with mixed success (Offshore Mag, 2004), and at present there are no installations.

There is significant interest by the petroleum industry in extraction of the potential hydrocarbon reserves located in the North Atlantic EZI, particularly in the offshore areas of the Faroe Islands, Iceland, and Norway. It is likely that hydrocarbon extraction in the area will increase in the coming years, therefore the potential risk to new developments will need to be taken into account for future launches from the SSC.

Cables and pipelines

Several subsea cables traverse the southern section of the North Atlantic EZI in UK and Faroese waters. These are (TeleGeography, 2020):

- FARICE-1: this cable connects Iceland, the Faroe Islands and Scotland and is owned by Icelandic company Farice. Landfall points are Dunnet Bay, Scotland, Funningsfjordur, Faroe Islands, and Seydisfjordur, Iceland;

- SHEFA-2: this cable connects the Faroe Islands with Shetland and north Scotland and is operated by the Faroese company Shefa. The cable makes landfall at Torshavn, Faroe Islands, Sandwick and Maywick in Shetland, Ayre of Cara in Orkney, and Banff in Scotland. There is also a cross-cable which connects Glen Lyon and BP Clair Ridge offshore;
- CANTAT-3: this cable connects Vestmannaeyjar, Iceland, Tjornuvik, Faroe Islands, and several locations in the North Sea and Denmark. It is also operated by Shefa;
- DANICE: this cable connects Landeyjasandur, Iceland, to Denmark, and is operated by Farice.

In addition to subsea cables, oil and gas pipelines are present in the southern portion of the North Atlantic EZI in UK and Norwegian waters. There are four pipelines that connect the various platforms in the oil and gas fields to the west of Shetland and those to the north-east of Shetland to onshore stations on Shetland such as the Sullom Voe Terminal. There is also a network of interconnecting pipelines between the numerous platforms in the oil and gas field to the north-east of Shetland.

Military

The North Atlantic EZI is used for military exercises by the North Atlantic Treaty Organization (NATO) and Russia. The North Atlantic EZI lies within Russia's bastion defence area, an area in the Norwegian Sea in which Russia has undertaken complex military exercises, including as recent as June 2020 (The Barents Observer, 2020). The North Atlantic EZI is also overlapped by the NATO sea exercise areas, which has been used for large exercises such as the Trident Juncture in 2018 (DW, 2018). Military exercises occur intermittently in these areas and can comprise both marine and aviation operations. There is potential for military activity to increase in the North Atlantic EZI in the future with increasing accessibility to the Arctic.

Other sea users

Other sea users include marine renewables (wave, wind, and tidal), aquaculture areas, marine aggregate dredging and disposal sites, carbon capture and storage, natural gas storage and minerals evaporites areas. There appear to be three other users of the marine environment in the North Atlantic EZI; aquaculture, waste disposal sites and marine renewable energy. There are many aquaculture sites located on the coast of Shetland. Aquaculture is of extreme economic importance to Shetland; in conjunction with fisheries, it accounts for £300 million a year of revenue (Fish Farming Expert, 2020). The two waste disposal sites, located offshore in Faroese and Norwegian waters, have been utilised for dumping munitions (EMODnet, 2020). There are two marine renewable energy installations in the North Atlantic EZI, at the coast of Shetland, which are Shetland Tidal Array and the NOVA 30 Demonstrator (EMODnet, 2020). Though there are no offshore wind farms within the North Atlantic EZI, one offshore wind farm, Hywind Tampen, is located adjacent to the southeast corner (4C Offshore, 2020). There are no marine aggregate dredging sites, carbon capture and storage, or natural gas storage and mineral evaporites areas in the North Atlantic EZI (EMODnet, 2020).

Socioeconomics/Tourism

Due to the offshore location of the North Atlantic EZI, there are minimal sources of marine tourism. Perhaps the only source is cruise liners, which may be present in the North Atlantic EZI whilst transiting between ports in the wider region (Marine Vessel Traffic, 2020). As passengers do not disembark in the North Atlantic EZI, cruise ships can be considered as part of shipping and navigation.

For further consideration of the socioeconomics and tourism of Shetland, please see Chapter 14 of this EIA Report.

Marine Archaeology

There is a paucity of readily available information on the marine archaeological features in offshore waters across several countries' jurisdiction. Information on marine archaeological data is likely held by the countries that overlap the North Atlantic EZI, namely Scotland, Denmark, Iceland, and Norway. The difficulty of acquiring this data has been determined to be disproportionate to the level of information required to provide a preliminary characterisation.

Information on the location of shipwrecks in Scottish waters is available to view on Marine Scotland's National Marine Plan interactive (NMPi) website. There are numerous wrecks in the Scottish extent of the North Atlantic EZI; to illustrate, see Figure A10.7 for the location of wrecks within 90 km of the launch site. It can be inferred from the NMPi that the number of wrecks decreases with distance from the coast and increasing water depth. The potential for maritime wrecks is greater closer to land, notably ports and historic transit passages, but there is still potential outside of this. It is understood that there were several notable battles that occurred in the North Atlantic EZI which may provide discrete areas where a greater number of finds would be located. Aviation and prehistory are likely to have a different spatial distribution. It is therefore logical to assume that the number of wrecks present in the North Atlantic EZI will be low.

There is limited palaoelandscape potential where glacial, though there may be a few discrete areas closer to land and in sheltered locations.

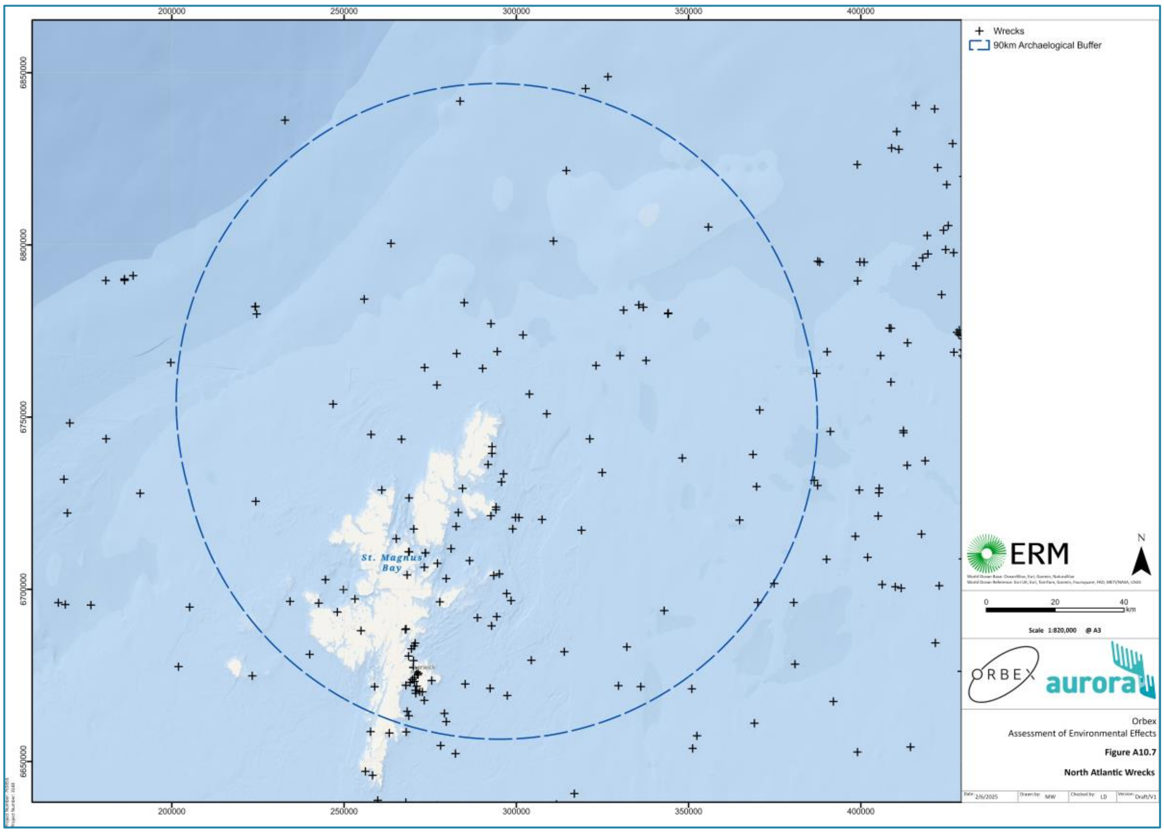


Figure A10.7: Recorded shipwrecks within 90 km of the launch site

Commercial Fisheries

The North Atlantic EZI overlaps the territorial fishing waters of several countries: Scotland, Norway, Denmark (Greenland and Faroe Islands). Additionally, the South Pacific EZI overlaps with fishing waters of the United States. Beyond these territorial waters fishing rights are controlled by the NEAFC.

The estimated fishing effort in the North Atlantic EZI is variable. Based on Figure A10.8, fishing effort in the southern portion of the North Atlantic EZI (between Scotland and the Faroe Islands) is high (~1.0 h/km^2) and decreases with increasing distance north through the North Atlantic EZI. With exception of south of Faroe Islands, fishing in most countries' waters is concentrated around the coast and so has minimal effort overlap with the North Atlantic EZI (Kroodsma et al., 2018; ICES, 2019a; 2019b). An assessment of estimated fishing effort in the NEAFC area indicated that fishing effort in 2005 was at or below 750 signals in each 0.5° × 0.5° grid cell for the portion of the NEAFC area that overlaps the North Atlantic EZI (FIRMS, 2009). The gear type that corresponded to the highest amount of effort in the North Atlantic EZI is pelagic trawls and seines, with bottom otter trawls used in highly localised areas also (Kroodsma et al., 2018; ICES, 2019a; 2019b).

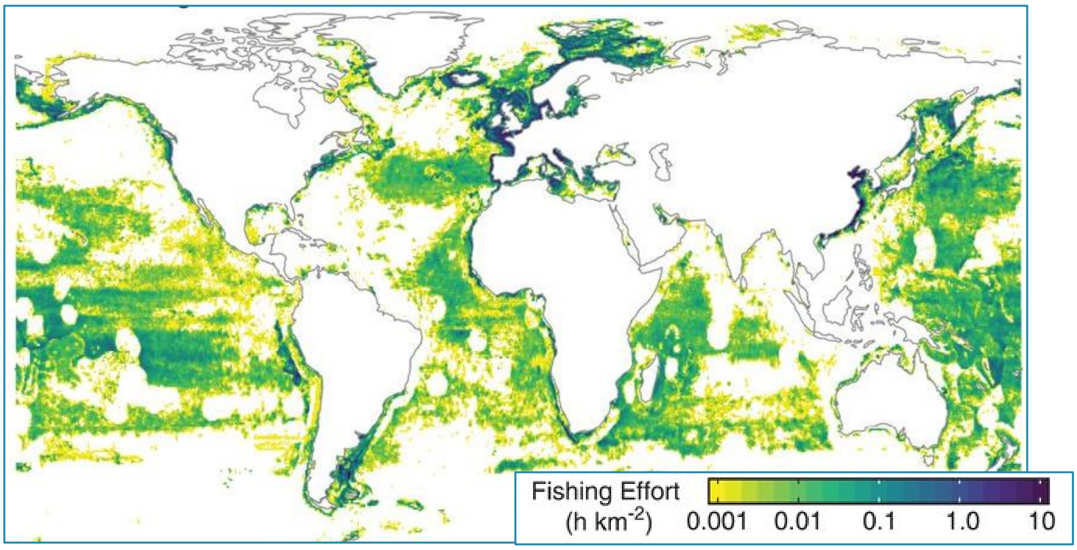


Figure A10.8: Total global fishing effort [hours fished per square kilometre (h/km²) in 2016 by all vessels with automatic identification system enabled (From: Kroodsma et al., 2018)

The North Atlantic EZI overlaps the following ICES Statistical Areas: IIa (Norwegian Sea), IVa (Northern North Sea), Va (Iceland Grounds), Vb (Faroes Grounds), and XIVa (North-East Greenland) (EC, 2020). ICES report on the annual nominal catches for all ICES regions submitted by the 20 ICES member countries (ICES, 2024). Data from the period 2017-2022 has been analysed for the purposes of characterising fishing in these areas.

Across all years in the period 2017-2022, the ICES area with the highest landings was Area IIa, which averaged approximately 3-4 mega tonnes (Mt) live weight per year. Landings in Area IIa have increased on a near-yearly basis, with the exception of 2019-2020 which was likely in-part due to the COVID-19 pandemic. Areas Va and Vb have traditionally been the second most productive, however total catch landed has significantly reduced in these areas since the COVID-19 pandemic. Area IVa has consistently reported approximately 1 Mt each year. Landings in North-East Greenland are notably lower than the other regions.

Table A10.5 Total annual catch landed in each ICES Statistical Area overlapped by the North Atlantic EZI (ICES, 2024)

Region	2017	2018	2019	2020	2021	2022
IIa Norwegian Sea	3,596,486	3,623,113	3,244,059	3,049,950	3,919,649	4,034,821
IVa Northern North Sea	997,513	1,142,339	1,072,657	1,174,479	812,354	946,073
Va Iceland Grounds	1,914,735	1,864,638	1,417,148	1,474,447	169,519	395,162
Vb Faroes Grounds	1,960,230	2,054,128	1,997,141	1,762,741	808,673	994,915
XIVa North-East Greenland	10,500	708	45	48	1,096	1,208

Through analysis of the catch data (ICES, 2024) it is also possible to comment on the relative contribution of different species to the overall landings in each area. In Area IIa, Atlantic herring, Atlantic mackerel, and Atlantic cod were the three most landed species for the period 2017-2022. A total of 7.3 Mt, 4.5 Mt, and 4.0 Mt were landed of Atlantic herring, Atlantic mackerel, and Atlantic cod, respectively. Atlantic herring and Atlantic mackerel were the two most commercially important species in Area IVa, with 2.1 Mt and 1.9 Mt landed, respectively. In Area Va, a total of 2.1 MT was landed for Atlantic cod, 1.6 Mt for capelin, and 1.0 Mt for Atlantic herring. For Area Vb, the majority of landings were for blue whiting at 7.3 Mt. The two major species landed in Area XIVa are Atlantic herring and Greenland halibut *Reinhardtius hippoglossoides*, though the amount landed is much smaller than in other areas. In summary, the most commercially important species across the region are Atlantic herring, Atlantic mackerel, Atlantic cod, capelin, and blue whiting.

The South Pacific Ocean has several important commercial fishing regions including The Cook Islands, Norfolk Island, the High seas and Australia. The most commercially important species across the region are Pacific salmon, Pacific herring, Pacific cod, yellowfin tuna, wahoo, sailfish, albacore, marlin and mahi-mahi.

A list of the major commercial fish species within the North Atlantic and South Pacific EZIs is presented in Appendix 10.6.

Appendix 10.3 Water Quality Risk Assessment

Orbex AEE Report Technical Appendix 10.3 - water quality risk matrix

Receptor	**Water quality**
Pressure Pathway/Impact	**Effects from Fuel Spillage**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Sea water exposed to hydrocarbons will lead to local increases in hydrocarbon concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Sea water exposed to hydrocarbons will lead to local increases in hydrocarbon concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	into the marine environment immediately upon entering it, following which it will disperse. Given the small amount of residual fuel expected, it is anticipated that hydrocarbon	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	7	2

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There is expected to be up to ten launches per year. However, the occurrence of residual fuel is anticipated to be rare as under normal circumstances all fuel it utilised during the launch.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Direct impacts to the hydrocarbon concentration of the sea water is likely to be measureable above natural variability, as there are limited other sources of hydrocarbons in the marine environment.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the hydrocarbon concentration of the sea water is likely to be measureable above natural variability, as there are limited other sources of hydrocarbons in the marine environment.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the hydrocarbon concentration of the sea water is likely to slightly detectable above the baseline (at a very localised scale), as there are limited other sources of hydrocarbons in the marine environment.	1
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	2	1
Overall Risk (sensitivity x exposure x magnitude)	Low	2

Receptor	**Water quality**
Pressure Pathway/Impact	**Effects from Metal Corrosion**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Sea water exposed to metal corrosion will lead to local increases in metal concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Sea water exposed to metal corrosion will lead to local increases in metal concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)	The source of metals (Orbex PRIME Launch Vehicle) will pass through the water column and then rest on the seabed. Metal corrision could happen throughout this passage, though it is anticipated to be highest at the seabed due to longevity in this environment. The Launch Vehicle has only small amounts of metals, predominantly aluminium, which is one of the least corrosive in the marine environment. Given the longevity of aluminium in the marine environment, water quality will recover over a long time scale.	2
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**9**	**2**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There is expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around the Orbex PRIME Launch Vehicle as it passes through the water column and rests at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the metal concentration of the sea water is likely to be measureable above natural variability. Aluminium is the main metal which is occurs naturally in the marine environment but in low concentration.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		0
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the metal concentration of the sea water is likely to be measureable above the baseline. Aluminium is the main metal which is occurs naturally in the marine environment but in low concentration.	
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	**1**	**1**

Overall Risk (sensitivity x exposure x magnitude)	**Low**	**2**

Receptor	**Water quality**
Pressure Pathway/Impact	**Effects from Microplastics and Debris**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The water quality of an area is of high environmental value and underpins the surrounding marine environment.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Microplastic exposure will lead to local increases in microplastic concentration which could lead to notable changes to the water's properties.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Microplastic exposure will lead to local increases in microplastic concentration which could affect the water's properties.	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The source of microplastics (Orbex PRIME Launch Vehicle) will pass through the water column and then rest on the seabed. Microplastics have the potential to be released throughout this passage. Given the small amount of plastics expected, it is anticipated that microplastic levels local to the Launch Vehicle will reach background levels over a short time scale.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**7**	**2**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	The water quality receptor is likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone around the Orbex PRIME Launch Vehicle as it sinks through the water column, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		0
1	Impact is measurable above natural variability (0-5% change in contaminant concentration)	Direct impacts to the microplastic concentration of the sea water is likely to be slightly measureable above natural variability.	1
2	Impact is measurable above natural variability (6-10% change in contaminant concentration)		
3	Impact is measurable above natural variability (>10% change in contaminant concentration)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		0
1	Impact is measurable above present baseline conditions (0-5% change in contaminant concentration)	Direct impacts to the microplastic concentration of the sea water is likely to be slightly measureable above the baseline (at a highly local scale).	1
2	Impact is measurable above present baseline conditions (6-10% change in contaminant concentration)		
3	Impact is measurable above present baseline conditions (>10% change in contaminant concentration)		

Overall Magnitude of Impact	**2**	**1**
Overall Risk (sensitivity x exposure x magnitude)	**Low**	**2**

Appendix 10.4 Biodiversity Risk Matrix

Orbex AEE Report Technical Appendix 10.4 - biodiversity risk matrix - plankton

Receptor	**Plankton**
Pressure Pathway/Impact	**Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value	Plankton themselves are not financially or cultural important, but they support other receptors that are.	1
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value		

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	The worst-case scenario of plankton being exposed to hydrocarbons could have lethal effects on individuals in the immediate vicinity of hydrocarbon spills.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	The worst-case scenario of plankton being exposed to hydrocarbons could have lethal effects on individuals in the immediate vicinity of hydrocarbon spills.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The source of contaminants (Orbex PRIME Launch Vehicles) will pass through the water column and then rest on the seabed. Plankton will predominantly be exposed whilst the Launch Vehicle omponent is in the water column. Given the high turnover of plankton in the ocean and the very small proportion of total plankton in the area predicted to be exposed, it is anticipated that plankton will recover within short timescales.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	7	2

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Plankton are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales		1
2	Receptor is exposed to impact over considerable spatial scales	Due to the highly limited impact zone around Orbex PRIME Launch Vehicle components as they sink through the water column, impacts will be low.	
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change)	Direct impacts to the contaminant levels of plankton are likely to be measureable above natural variability.	1
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	Direct impacts to the contaminant levels of plankton are not likely to affect the plankton baseline, when taking into account the very small spatial scale of effect in the context of the entire Study Area A and the abundance and high turnover of plankton.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change principle in baseline population)		

Overall Magnitude of Impact	1	1
Overall Risk (sensitivity x exposure x magnitude)	Low	2

Receptor	Plankton
Pressure Pathway/Impact	Disturbance Effects from the Return of Launch Parts

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value	Plankton themselves are not financially or cultural important, but they support other receptors that are.	1
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value		

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	The worst-case scenario of plankton being exposed to the noise of impact could have lethal effects on individuals in the immediate vicinity.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	The worst-case scenario of plankton being exposed to the noise of impact could have lethal effects on individuals in the immediate vicinity.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	The worst-case scenario of plankton being exposed to the noise of impact could have lethal effects on individuals in the immediate vicinity. At an individual level the receptor would not be able to recover from this.	3

Overall Sensitivity of the Receptor	**10**	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Plankton are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone around Launch Vehicle components as they enter the marine environment, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	Direct impacts to the mortality rate of plankton will not be measureable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	Direct impacts to the mortality rate of plankton will not cause a measurable change in the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change principle in baseline population)		

Overall Magnitude of Impact	**0**	**0**
Overall Risk (sensitivity x exposure x magnitude)	**Low**	**0**

Orbex AEE Report Technical Appendix 10.4 - biodiversity risk matrix - benthics

Receptor	Benthic Habitats
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The seabed habitats within the EZI are well represented in the wider region. There is likely presence of VMEs in the EZI, though these are only protected from the impacts of fishing and not other seabed impacts. There are designated benthic habitat features of MPAs in the region.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	The benthic communities are likely to be sensitive to change as they have had limited exposure to anthropogenic activities and the introduction of contaminants.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure	Benthic habitats are adaptable to changes in contaminant levels as they can accumulate a certain level before experiencing physiological effects	2
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)	The source of contaminants will be present for different lengths of time, the longest being the metal and associated corrosion, which will be present for extended periods. Once the source of contaminants has broken down benthic habitats will be able to fully recover. The contaminants may remain in the system of benthic species for a notable amount of time.	2
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	9	2

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		2
3	Receptor is exposed to impact over extensive periods of time	Benthic habitats are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around Launch Vehicle components at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	3	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change)	Direct impacts to the contaminant levels of benthic habitats are likely to be measureable above natural variability.	1
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification

0	Impact is not measurable above present baseline conditions	Direct impacts to the contaminant levels of benthic habitats are not likely to affect the benthic habitat baseline, when taking into account the very small spatial scale of effect in the context of the entire EZI.	0	
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)			
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)			
3	Impact is measurable above present baseline conditions (>10% change in baseline population)			
Overall Magnitude of Impact			**1**	**1**
Overall Risk (sensitivity x exposure x magnitude)			**Low**	**2**

Receptor	**Benthic Habitats**
Pressure Pathway/Impact	**Direct loss of seabed habitat via deposition of material on the seabed**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The seabed habitats within the EZI are well represented in the wider region. There is likely presence of VMEs in the EZI, though these are only protected from the impacts of fishing and not other seabed impacts. There are designated benthic habitat features of MPAs in the region.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	The worst-case example of VMEs are intolerant of direction deposition of material on them and would experience substantial change.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	The worst-case example of VMEs are not adaptable to direction deposition of material on them and would be susbstantially affected.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)	The Orbex PRIME Launch Vehicle will likely break down in the marine environment. Once this occurs, the receptor will be able to recover i.e. recolonise that area. Given the size of the Launch Vehicle in comparison to the size of the habitat, only a small proportion will be affected so recolonisation from surrounding habitats is possible.	2
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**11**	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Benthic habitats are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There is expected to be up to ten launches per year. However, the likelihood of Orbex PRIME Launch Vehicle components repeatedly encountering an MPA with designated benthic feature or a VME is extemely low, taking into account the extent of the study area.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around Orbex PRIME Launch Vehicle components at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural va	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change)	Direct impacts to the benthic habitats are likely to be measureable above natural variability as there is not element of natural variability and the most sensitive habitats are long-lived.	1
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environm	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)	Direct impacts to the benthic habitats are only likely to have a small effect on the baseline, when taking into account the very small spatial scale of effect in the context of the extent of benthic habitats in the EZI.	1
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact	2	1

Overall Risk (sensitivity x exposure x magnitude)	Low	3

Receptor	Fish
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The number of fish species in the study area is very high. Several of these species are commercially important.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Fish species exposed to increased contaminants may accumulate them, though only in low amounts due to the low amounts predicted to be released and the high mobility of fish species.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Fish species that accumulate low levels of contaminants will only be marginally affected and show minimal physiological effects at worst.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	The source of contaminants (Orbex PRIME Launch Vehicle) will pass through the water column and then rest on the seabed. The most persistent source of contamination is the metal and associated corrosion, which will be present for extended periods on the seabed. However, given the very small amount of exposure predicted, it is expected that fish species can recover within short timescales.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	5	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Fish are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around Launch Vehicle components as they pass through the water column and rest at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change)	Direct impacts to the contaminant levels of fish are likely to be measureable above natural variability.	1
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	Direct impacts to the contaminant levels of fish are not likely to affect the fish baseline, when taking into account the very small spatial scale of effect in the context of the entire EZI and the high mobility of fish.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact	1	1
Overall Risk (sensitivity x exposure x magnitude)	Low	1

Receptor	Fish
Pressure Pathway/Impact	Disturbance Effects from the Return of Launch Parts

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The number of fish species in the study area is very high. Several of these species are commercially important.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	The worst-case scenario of fish being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity, which would cause a substantial change.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	The worst-case scenario of fish being exposed to the noise of impact could have injury effect on individuals in the immediate vicinity, which would affect them substantially.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	The worst-case scenario of fish being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity. At an individual level the receptor would not be able to recover from this.	3

Overall Sensitivity of the Receptor	**12**	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Fish are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone of noise and visual disturbance around the Orbex PRIME Launch Vehicle stages, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	Direct impacts to fish will not be measureable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	Direct impacts to fish will not cause a measurable change in the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change principle in baseline population)		

Overall Magnitude of Impact	**0**	**0**

Receptor	Marine Megafauna
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics - indirect effects to prey

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine megafauna have a high cultural value and many species are protected by international law. The Arctic Region region is likely to have presence of marine megafauna, though it is not considered a special habitat. There are not anticipated to be any calving or nursery grounds for cetaceans due to the latitude. There is the presence of pupping areas for pinnipeds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Marine megafauna are very tolerant of impacts as they range over a wide area and alternative feeding areas are available to them.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Marine megafauna are considered very adaptable by virtue of their considerable mobility and ability to forage over wide ranges.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Species that target that area would be able to return as soon as the Orbex PRIME Launch Vehicle component had passed through the water column (predicted to be <1 year)	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor		
	5	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Species are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone from the returning Laucnh Vehicle components and wide foraging ranges of marine megafauna exposure to impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact		
	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	The magnitude of the impact (i.e. any changes at a population scale) will not be detectable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The magnitude of the impact (i.e. the amount of feeding habitat that becomes unvailable on the short timescale) will not be detectable above the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact		
	0	0

Overall Risk (sensitivity x exposure x magnitude)		
	Negligible	0

Receptor	Marine Megafauna
Pressure Pathway/Impact	Direct stike causing mortality/serious injury

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine megafauna have a high cultural value and many species are protected by international law. The Arctic Region region is likely to have presence of marine megafauna, though it is not considered a special habitat. There are not anticipated to be any calving or nursery grounds for cetaceans due to the latitude. There is the presence of pupping areas for pinnipeds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	If an individual marine megafauna is struck by returning parts of the Orbex PRIME Launch Vehicle it will likely have lethal or serious injury consequences	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	If an individual marine megafauna is struck by returning parts of the Launch Vehicle it will likely have lethal or serious injury consequences	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	If an individual marine megafauna is struck by returning parts of the Launch Vehicle it will likely have lethal or serious injury consequences which are not recoverable	3

Overall Sensitivity of the Receptor	12	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Species are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year. However, the likelihood of such an event occurring is very low, a single individual will only be exposed to this impact pathway a maximum of one time during its lifetime.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly spatially limited impact zone from the returning Launch Vehicles and wide foraging ranges of Marine megafauna exposure to impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	The very low level of effects on Marine megafauna will not be measurable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The very low level of effects on Marine megafauna will not be measurable above the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact	0	0
Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Receptor	Marine Megafauna
Pressure Pathway/Impact	Disturbance Effects from the Return of Launch Parts

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine megafauna have a high cultural value and many species are protected by international law. The Arctic Region region is likely to have presence of marine megafauna, though it is not considered a special habitat. There are not anticipated to be any calving or nursery grounds for cetaceans due to the latitude. There is the presence of pupping areas for pinnipeds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	The worst-case scenario of marine megafauna being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity, which would cause a substantial change.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	The worst-case scenario of marine megafauna being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity, which would affect them substantially.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	The worst-case scenario of marine megafauna being exposed to the noise of impact could have injury effects on individuals in the immediate vicinity. At an individual level the receptor would not be able to recover from this.	3

Overall Sensitivity of the Receptor	12	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Marine megafauna are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone of noise and visual disturbance around the Launch Vehicle stages, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	Direct impacts to marine megafauna will not be measureable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	Direct impacts to marine megafauna will not cause a measurable change in the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change principle in baseline population)		

Overall Magnitude of Impact	0	0

Overall Risk (sensitivity x exposure x magnitude)	Low	0

Receptor	Marine Ornithology
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics - indirect effects to prey

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine ornithological receptors have a high cultural value and many species are protected by international law. The Arctic Region region has notable presence of marine ornithological features, though it is not considered a special habitat. There is the presence of breeding colonies for seabirds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Marine ornithological features are very tolerant of impacts as they range over a wide area and alternative feeding areas are available to them.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Marine ornithological features are considered very adaptable by virtue of their ability to forage over wide ranges and take a variety of prey.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Species that target that area would be able to return as soon as the Launch Vehicle component had passed through the water column (predicted to be <1 year)	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	5	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Species are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone from the returning LVs and wide foraging ranges of seabirds exposure to impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	The magnitude of the impact (i.e. any changes at a population scale) will not be detectable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The magnitude of the impact (i.e. the amount of feeding habitat that becomes unvailable on the short timescale) will not be detectable above the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact	0	0
Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Receptor	Marine Ornithology
Pressure Pathway/Impact	Direct stike causing mortality/serious injury - whilst loafing/flying

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine ornithological receptors have a high cultural value and many species are protected by international law. The Arctic Region region has notable presence of marine ornithological features, though it is not considered a special habitat. There is the presence of breeding colonies for seabirds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	If a seabird is struck by returning parts of the Orbex PRIME Launch Vehicle it will likely have lethal or serious injury consequences	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	If a seabird is struck by returning parts of the Orbex PRIME Launch Vehicle it will likely have lethal or serious injury consequences to which it cannot adapt	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	If a seabird is struck by returning parts of the Orbex PRIME Launch vehicle it will likely have lethal or serious injury consequences which are not recoverable	3

Overall Sensitivity of the Receptor	12	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Species are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year. However, a single individual will only be exposed to this impact pathway a maximum of one time during its lifetime.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly spatially limited impact zone from the returning Launch Vehicles and wide habitat usage by seabirds exposure to impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	The very low level of effects on seabirds will not be measurable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The very low level of effects on seabirds will not be measurable above the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change in baseline population)		

Overall Magnitude of Impact	0	0
Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Receptor	Marine Ornithology
Pressure Pathway/Impact	Disturbance Effects from the Return of Launch Parts

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Marine ornithological receptors have a high cultural value and many species are protected by international law. The Arctic Region region has notable presence of marine ornithological features, though it is not considered a special habitat. There is the presence of breeding colonies for seabirds, but only on land.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed	Seabirds are predicted to be entirely tolerant of the disturbance effect from the presence of an Orbex PRIME Launch Vehicle and recovery vessel at the sea surface.	2
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Seabirds are predicted to have a high adaptability to the disturbance effect from the presence of an Orbex PRIME Launch Vehicle and recovery vessel at the sea surface.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	As seabirds are predicted to not be changed or affected by the disturbance effect, they will reocver instantly.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**6**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time	Marine ornithology features are likely to be exposed to impacts over considerable periods of time, i.e. 30 years, however disturbance events will only occur for a minimal period of time (up to 45 minutes per launch)	1
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time		

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the limited impact zone of noise and visual disturbance around the LV stages/vessel, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**2**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	Direct impacts to marine ornithology will not be measureable above natural variability.	0
1	Impact is measurable above natural variability (0-5% change)		
2	Impact is measurable above natural variability (6-10% change)		
3	Impact is measurable above natural variability (>10% change)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	Direct impacts to marine ornithology will not cause a measurable change in the baseline.	0
1	Impact is measurable above present baseline conditions (0-5% change in baseline population)		
2	Impact is measurable above present baseline conditions (6-10% change in baseline population)		
3	Impact is measurable above present baseline conditions (>10% change principle in baseline population)		

Overall Magnitude of Impact	**0**	**0**
Overall Risk (sensitivity x exposure x magnitude)	**Negligible**	**0**

Orbex AEE Report Technical Appendix 10.4 - biodiversity risk matrix - marine protected areas

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Effects from Fuel Spillage/Metal Corrosion/Debris and Microplastics	See the risk matrix for water quality, benthic habitats, and marine ornithology for effects to designated marine ecological and water quality features of the MPAs.

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Direct loss of seabed habitat via deposition of material on the seabed	See the risk matrix for benthics for effects to designated marine ecological and water quality features of the MPAs.

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Direct strike causing mortality/serious injury	See the risk matrix for marine ornithology for effects to designated marine ecological features of the MPAs.

Receptor	Marine Protected Areas	
Pressure Pathway/Impact	Disturbance Effects from the Return of Launch Parts	See the risk matrix for plankton, fish, marine megafauna and marine ornithology for effects to designated marine ecological features of the MPAs.

Appendix 10.5 Humans and Human Activities Risk Matrix

Orbex AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	**Commercial and Recreational Fishing**
Pressure Pathway/Impact	**Displacement of fishing stock**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The study area supports commercially important fisheries for several nations.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	fishing stocks.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Adaptability is high as most fishing vessels will be able to move to follow displaced fishing stocks.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	vessels are adaptable and would also be able to return to the area where fish were.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**5**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time	the proposed impact, the longevity of the exposure is reduced.	2
3	Receptor is exposed to impact over extensive periods of time		

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to ten launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around LVs as they pass through the water column and rest at the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**4**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	variation.	0
1	Impact is measurable above natural variability (0-5% change in fishing stock)		
2	Impact is measurable above natural variability (6-10% change in fishing stock)		
3	Impact is measurable above natural variability (>10% change in fishing stock)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The fish stock baseline will not change as a result of the Orbex PRIME Launch Vehicle components entering the marine environment.	0
1	Impact is measurable above present baseline conditions (0-5% change in fishing stock)		
2	Impact is measurable above present baseline conditions (6-10% change in fishing stock)		
3	Impact is measurable above present baseline conditions (>10% change in fishing stock)		

Overall Magnitude of Impact	**0**	**0**
Overall Risk (sensitivity x exposure x magnitude)	**Negligible**	**0**

Receptor	**Commercial and Recreational Fishing**
Pressure Pathway/Impact	**Vessel displacement**

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	The study area supports commercially important fisheries for several nations.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	be able to move away from these locations if required. Given the highly localised nature of the impact zones in comparison to the distribution of target	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Adaptability is high as most fishing vessels will be able to move to areas outside the impact zone.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Fishing vessels are highly mobile and will be able to return to an area once an LV has passed, predicted to occur on the short-term scale (i.e. hours).	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	5	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Fishing vessels are likely to be exposed to impacts over considerable periods of time, i.e. the duration of the 30 year licence.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)		
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)	There is expected to be up to 10 launches per year in the initial years, rising to a maximum of 30 launches per year.	1
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning LVs, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	5	2

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		
1	Impact is measurable above natural variability (0-5% change in distribution of fishing vessels)	The displacement of fishing vessels as a result of LVs entering the marine environment will be slightly detectable above natural variation.	1
2	Impact is measurable above natural variability (6-10% change in distribution of fishing vessels)		
3	Impact is measurable above natural variability (>10% change in distribution of fishing vessels)		

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The fishing vessel presence baseline will not change as a result of the exclusion zones around LVs entering the marine environment.	0
1	Impact is measurable above present baseline conditions (0-5% change in distribution of fishing vessels)		
2	Impact is measurable above present baseline conditions (6-10% change in distribution of fishing vessels)		
3	Impact is measurable above present baseline conditions (>10% change in distribution of fishing vessels)		

Overall Magnitude of Impact	1	1
Overall Risk (sensitivity x exposure x magnitude)	Low	2

Orbex AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	Human infrastructure (subsea cables/pipelines)
Pressure Pathway/Impact	Direct impact as a result of Orbex PRIME Launch Vehicle components returning

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Subsea cables and pipelines are of high financial value.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	structural damage.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	Subsea cables and pipelines would potentially be not adapble to the impact of an LV as it could cause significant structural damage.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	damage.	3

Overall Sensitivity of the Receptor	12	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Human infrastructure are likely to be exposed to impacts over extensive periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year. However, the likelihood of Launch Vehicle components repeatedly encountering any given human infrastructure is extemely low, taking into account the extent of the EZI.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the highly limited impact zone around LVs, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)		N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)		N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)		N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)	If the impact was to occur then the magnitude of the impact would be high. However, it is considered that the likelihood of such an impact is negligible,	1
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	1	1

Overall Risk (sensitivity x exposure x magnitude)	Low	3

Orbex AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	Marine and Coastal Tourism
Pressure Pathway/Impact	Interference/Displacement

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value	The EZI supports a moderate amount of tourism and recreation activitly, which are mostly concentrated at the coast.	2
3	Receptor has a high financial, environmental or cultural value		

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Notices will be given out prior to launches from the SaxaVord Spaceport, which will allow many tourism/recreational activities to temporarily alter location or pause for	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Most vessels are highly mobile and will be able to adapt if required to move away, with only small vessels that are slightly less adaptable.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	All vessels are highly mobile and will be able to return to an area once an Orbex PRIME Launch Vehicle has passed, predicted to occur on the short-term scale (i.e.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	**4**	**1**

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time	Tourism activities are likely to be exposed to impacts over considerable periods of time, i.e. 30 years, however only for a short period per launch (45 minutes), up to a	1
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time		

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning Orbex PRIME Launch Vehicles and the concentration of most tourist activities around the coast,	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	**2**	**1**

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	N/A	N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)	N/A	N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)	N/A	N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)	N/A	N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The current tourism baseline will not impacted by the temporary implementation of small exclusion zones.	0
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)		
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	**0**	**0**
Overall Risk (sensitivity x exposure x magnitude)	**Negligible**	**0**

Orbex AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	Military Activities
Pressure Pathway/Impact	Vessel displacement

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Military activities are important in terms of economics and defence. Military activities occur intermittently in the EZI.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	There will be communications wrt to the location of exclusion zones around the predicting landing area of Orbex PRIME Launch Vehicle components.	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Military vessels are highly mobile and will be able to adapt if required to move away, with only small vessels that are slightly less adaptable.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	Military vessels are highly mobile and will be able to return to an area once an Orbex PRIME Launch Vehicle has passed, predicted to occur on the short-	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	5	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Vessels are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year. Howver, military exercises occur on an intermittent basis i.e. not every month.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning Orbex PRIME Launch Vehicle components, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	N/A	N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)	N/A	N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)	N/A	N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)	N/A	N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	exclusion zones.	0
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)		
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	0	0
Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Orbex AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	Navigation and Shipping
Pressure Pathway/Impact	Vessel displacement

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value	The EZI supports a moderate density of shipping traffic, which is mostly concentrated at the coast.	2
3	Receptor has a high financial, environmental or cultural value		

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed	Vessels will receive communications wrt to the location of exclusion zones around the predicting landing area of Orbex PRIME Launch Vehicless. Most vessels are	1
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed		

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure	Most vessels are highly mobile and will be able to adapt if required to move away, with only small vessels that are slightly less adaptable.	1
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure		

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)	All vessels are highly mobile and will be able to return to an area once an Orbex PRIME Launch Vehicle has passed, predicted to occur on the short-term scale (i.e.	0
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale		

Overall Sensitivity of the Receptor	4	1

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Vessels are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year.	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around returning Orbex PRIME Launch Vehicle components, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability	N/A	N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)	N/A	N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)	N/A	N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)	N/A	N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions	The current shipping baseline will not impacted by the temporary implementation of small exclusion zones.	0
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)		
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	0	0

Overall Risk (sensitivity x exposure x magnitude)	Negligible	0

Orbex AEE report Appendix 10.5 - humans and human activities risk matrix

Receptor	Maritime archaeology
Pressure Pathway/Impact	Direct impacts - damage

Sensitivity of the Receptor

Value (importance, rarity, quality) of receptor	Qualifying Statement	Consideration	Classification
0	Receptor has no measurable financial, environmental or cultural value		
1	Receptor has a low financial, environmental or cultural value		
2	Receptor has a medium financial, environmental or cultural value		
3	Receptor has a high financial, environmental or cultural value	Any marine archaeological site in the study area is likely to have a high value associated, dependent on the items era.	3

Tolerance of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely tolerant of the impact and will not exhibit change if exposed		
1	Receptor is very tolerant of the impact and will exhibit marginal change if exposed		
2	Receptor is slightly tolerant of the impact and will exhibit noticeable change if exposed		
3	Receptor is intolerant of the impact and will exhibit substantial change if exposed	The tolerance of any archaeological sites in the area are considered relatively vulnerable via impact.	3

Adaptability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor is entirely adaptable and as such will be unaffected by exposure		
1	Receptor is very adaptable and as such will be marginally affected by exposure		
2	Receptor is slightly adaptable and as such will be noticeably affected by exposure		
3	Receptor is not adaptable and as such will be substantially affected by exposure	There is no adaptability of any archaeological items or sites.	3

Recoverability of receptor	Qualifying Statement	Consideration	Classification
0	Receptor will recover entirely within short timescales (<1 year)		
1	Receptor will recover entirely within medium timescales (1-5 years)		
2	Receptor will recover entirely within long timescales (>5 years)		
3	Receptor will not entirely recover over any timescale	As any archaeological finds are anthropogenic items or sites, they are unable to recover.	3

Overall Sensitivity of the Receptor	12	3

Exposure of Receptor to Impact

Exposure to the impact (time)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited periods of time		
2	Receptor is exposed to impact over considerable periods of time		
3	Receptor is exposed to impact over extensive periods of time	Marine archaeological sites are likely to be exposed to impacts over considerable periods of time, i.e. 30 years.	3

Exposure to the impact (frequency)	Qualifying Statement	Consideration	Classification
0	Receptor is very infrequently exposed to impact over limited periods of time (<1 event per month for the duration of the licence)	There are expected to be up to ten launches per year. However, the likelihood of Orbex PRIME Launch Vehicles repeatedly impacting any given marine	0
1	Receptor is infrequently exposed to impact over limited periods of time (1-5 events per month for the duration of the licence)		
2	Receptor is frequently exposed to impact over considerable periods of time (5-15 events per month for the duration of the licence)		
3	Receptor is constantly exposed to impact over considerable periods of time (>15 events per month for the duration of the licence)		

Exposure to the impact (space)	Qualifying Statement	Consideration	Classification
0	Receptor is not exposed to impact		
1	Receptor is exposed to impact over limited spatial scales	Due to the small spatial extent of the impact zone around Launch Vehicles reaching the seabed, impacts will be low.	1
2	Receptor is exposed to impact over considerable spatial scales		
3	Receptor is exposed to impact over extensive and unconfined spatial scales		

Overall Exposure of Receptor to Impact	4	1

Magnitude of Impact

Magnitude of the impact (in the context of natural variability)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above natural variability		N/A
1	Impact is measurable above natural variability (0-5% change in total numbers of individuals)		N/A
2	Impact is measurable above natural variability (6-10% change in total numbers of individuals)		N/A
3	Impact is measurable above natural variability (>10% change in total numbers of individuals)		N/A

Magnitude of the impact (in the context of environmental baseline conditions)	Qualifying Statement	Consideration	Classification
0	Impact is not measurable above present baseline conditions		
1	Impact is measurable above present baseline conditions (0-5% change in total undisturbed available habitat)	There is a very low likelihood that Orbex PRIME Launch Vehicles reaching the seabed will have known impact on marine archaeological sites, but if this did	1
2	Impact is measurable above present baseline conditions (6-10% change in total undisturbed available habitat)		
3	Impact is measurable above present baseline conditions (>10% change in total undisturbed available habitat)		

Overall Magnitude of Impact	1	1
Overall Risk (sensitivity x exposure x magnitude)	Low	3

Appendix 10.6 Baseline Species EZI

Grouping	Family	Scientific Name	English Name	EZI Stage	Global Conservation Status	Abundance	Distribution	Habitat	Prey
Cetacea	Balaenopteridae	*Balaenoptera acutorostrata*	Minke whale	North Atlantic and South Pacific EZI	Least concern	27,000 (western North Pacific); 156,000 (North Atlantic)	Global distribution	Oceanic, Neritic	Euphausiids (krill), sandeels, capelin, herring, haddock, anchovy, pollock
Cetacea	Balaenopteridae	*Balaenoptera borealis*	Sei whale	South Pacific EZI	Endangered	35,000 (North Pacific)	Global, except polar seas	Oceanic	Euphausiids (krill), small fishes
Cetacea	Balaenopteridae	*Balaenoptera edeni*	Bryde's whale	South Pacific EZI	Least concern	26,300 (North Pacific)	Global tropical and subtropical	Oceanic, Neritic	Euphausiids (krill), mackerel, anchovies, pilchard
Cetacea	Balaenopteridae	*Balaenoptera physalus*	Fin whale	North Atlantic and South Pacific EZI	Vulnerable	50,000 (North Pacific)	Global temperate and subpolar	Oceanic, Neritic	Fishes, crustaceans
Cetacea	Delphinidae	*Feresa attenuata*	Pygmy killer whale	South Pacific EZI	Least concern	>40,000	Global tropical and subtropical	Deep Oceanic	Cephalopods and fishes
Cetacea	Delphinidae	*Globicephala macrorhynchus*	Short-finned pilot whale	South Pacific EZI	Least concern	>700,000	Global temperate and tropical	Deep Oceanic	Cephalopods
Cetacea	Kogiidae	*Kogia breviceps*	Pygmy sperm whale	South Pacific EZI	Least concern	>10,000	Global temperate and tropical	Deep Oceanic	Cephalopods
Cetacea	Kogiidae	*Kogia sima*	Dwarf sperm whale	South Pacific EZI	Least concern	7,138 (Hawaii)	Global tropical and warm temperate	Oceanic	Cephalopods
Cetacea	Balaenopteridae	*Balaenoptera musculus*	Blue whale	South Pacific EZI	Endangered	5,000-15,000	Global, except Mediterranean, Okhotsk, and Bering Sea	Oceanic, Neritic	Euphausiids (krill)
Cetacea	Balaenopteridae	*Megaptera novaeangliae*	Humpback whale	North Atlantic and South Pacific EZI	Least concern	84,000-135,000	Global distribution	Oceanic, Neritic	Euphausiids (krill), small fishes
Cetacea	Ziphiidae	*Mesoplodon densirostris*	Blainville's beaked whale	North Atlantic and South Pacific EZI	Least concern	Data deficient	Global temperate and tropical	Oceanic	Cephalopods, fishes, crustaceans
Cetacea	Ziphiidae	*Mesoplodon ginkgodens*	Ginkgo-toothed beaked whale	South Pacific EZI	Data deficient	Data deficient	Tropical and warm temperate western Pacific Ocean	Deep Oceanic	Cephalopods
Cetacea	Delphinidae	*Orcinus orca*	Killer whale	North Atlantic and South Pacific EZI	Data deficient	>50,000	Global distribution	Oceanic, Neritic	Highly varied; marine mammals, seabirds, sea turtles, fish, cephalopods
Cetacea	Delphinidae	*Peponocephala electra*	Melon-headed whale	South Pacific EZI	Least concern	>180,000	Global tropical and subtropical	Deep Oceanic	Mesopelagic fishes, cephalopods, crustaceans
Cetacea	Physeteridae	*Physeter macrocephalus*	Sperm whale	North Atlantic and South Pacific EZI	Vulnerable	>100,000	Global distribution	Deep Oceanic	Deep-water cephalopods
Cetacea	Delphinidae	*Pseudorca crassidens*	False killer whale	South Pacific EZI	Near threatened	>60,000	Global tropical, also subtropical and warm temperate neritic	Oceanic, some Neritic	Tuna, billfishes, cephalopods
Cetacea	Ziphiidae	*Ziphius cavirostris*	Cuvier's beaked whale	North Atlantic and South Pacific EZI	Least concern	>100,000	Global except shallow areas and high-la	Deep Oceanic	Deep-water cephalopods
Cetacea	Delphinidae	*Grampus griseus*	Risso's dolphin	North Atlantic and South Pacific EZI	Least concern	Data deficient	Global temperate and tropical	Deep Oceanic	Mesopelagic and benthic cephalopods
Cetacea	Delphinidae	*Stenella attenuata*	Pantropical spotted dolphin	South Pacific EZI	Least concern	15,917 (Hawaii)	Global tropical and subtropical	Oceanic, Neritic	Epipelagic and mesopelagic fishes; gadids, scombroids, clupeoids and cephalopods
Cetacea	Delphinidae	*Stenella coeruleoalba*	Striped dolphin	North Atlantic and South Pacific EZI	Least concern	>1,000,000	Global tropical and warm temperate	Oceanic, some Neritic	Pelagic fish, benthopelagic fish, cephalopods
Cetacea	Delphinidae	*Stenella longirostris*	Spinner dolphin	South Pacific EZI	Least concern	>1,000,000	Global tropical and warm temperate	Oceanic, some Neritic	Pelagic fish, cephalopods, crustaceans
Cetacea	Delphinidae	*Steno bredanensis*	Rough-toothed dolphin	South Pacific EZI	Least concern	>220,000	Global tropical and warm temperate	Oceanic	Pelagic fish, cephalopods
Cetacea	Delphinidae	*Delphinus delphis*	Common dolphin	North Atlantic and South Pacific EZI	Least concern	>1,000,000	Global temperate and tropical	Oceanic, Neritic	Epipelagic and mesopelagic fishes; gadids, scombroids, clupeoids and cephalopods
Cetacea	Delphinidae	*Lagenodelphis hosei*	Fraser's dolphin	South Pacific EZI	Least concern	>320,000	Global tropical and subtropical	Oceanic	Mesopelagic fishes; myctophids, cephalopods, crustaceans
Cetacea	Delphinidae	*Tursiops truncatus*	Bottlenose dolphin	North Atlantic and South Pacific EZI	Least concern	>750,000	Global temperate and tropical	Oceanic, Neritic	Pelagic and demersal fish, cephalopods, crustaceans
Cetacea	Delphinidae	*Globicephala melas*	Long-finned pilot whale	North Atlantic EZI	Least concern	344,000 (Faroe Islands)	North Atlantic Ocean, Temperate and sub-polar southern hemisphere	Oceanic	Cephalopods, fishes
Cetacea	Ziphiidae	*Mesoplodon grayi*	Gray's beaked Whale	South Pacific EZI	Data deficient	Data deficient	Circum south polar	Oceanic	Squid, fishes

Grouping	Scientific Name	English Name	Conservation Status	EZI Stage	Distribution
Tropicbird	*Phaethon lepturus*	White-tailed Tropicbird	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Tropicbird	*Phaethon rubricauda*	Red-tailed Tropicbird	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Petrel	*Bulweria bulwerii*	Bulwer’s Petrel	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Petrel	*Pterodroma hypoleuca*	Bonin Petrel	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Petrel	*Pterodroma sandwichensis*	Hawaiian Petrel	Endangered	South Pacific EZI	Hawaii, Pacific Ocean
Petrel	*Oceanodroma castro*	Band-rumped storm-petrel	Least Concern	South Pacific EZI	Hawaii, Japan, Pacific
Petrel	*Oceanodroma tristrami*	Tristram’s Storm-Petrel	Least Concern	South Pacific EZI	Hawaii, Japan, Pacific
Shearwater	*Ardenna pacifica*	Wedge-tailed shearwater	Least Concern	South Pacific EZI	Hawaii, Japan, Pacific
Shearwater	*Puffinus auricularis newelli*	Newell’s shearwater	Endangered	South Pacific EZI	Hawaii, Pacific Ocean
Shearwater	*Puffinus nativitatis*	Christmas shearwater	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Tern	*Gygis alba*	White tern	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Tern	*Onychoprion fuscatus*	Sooty Tern	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Tern	*Onychoprio lunatus*	Gray-backed Tern	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Tern	*Anous minutus*	Hawaiian Black Noddy	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Tern	*Anous stolidus*	Brown Noddy	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Tern	*Procelsterna cerulean*	Blue-gray Noddy	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Gannet	*Sula dactylatra*	Masked (blue-faced) booby	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Gannet	*Sula leucogaster*	Brown booby	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Gannet	*Sula sula*	Red-footed booby	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Frigatebird	*Fregata minor*	Great frigatebird	Least Concern	South Pacific EZI	Hawaii, Pacific Ocean
Albatross	*Phoebastria albatrus*	Short-tailed albatross	Vulernable	South Pacific EZI	Hawaii, Pacific Ocean
Auk	*Synthliboramphus antiquus*	Ancient murrelet	Least Concern	South Pacific EZI	Alaskan Peninsula, North Pacific, West Pacific, Sea of Japan
Murrelet	*Brachyramphus brevirostris*	Kittlitz's Murrelet	Near Threatened	South Pacific EZI	East Siberian Sea, Bering Sea, Alaskan Peninsula, North Pacific
Fulmar	*Fulmarus glacialis*	Northern fulmar	Least Concern	North Atlantic and South Pacific	North Atlantic, Arctic Ocean Alaskan Peninsula, North Pacific,
Albatross	*Diomedea epomophora*	Southern Royal Albatross	Vunerable	South Pacific EZI	Southern Pacific
Noddy	*Anous stolidus*	Brown Noddy	Least Concern	South Pacific EZI	Central America, South Pacific, South Atlantic, Indian Ocean
Noddy	*Anous minutus*	Black Noddy	Least Concern	South Pacific EZI	Southern Pacific, Hawaii, Southern Atlantic
Frigatebird	*Fregata magnificens*	Magnificent frigatebird	Least Concern	South Pacific EZI	Southern Pacific, South America
Noddy	*Anos ceruleus*	Blue Noddy	Least Concern	South Pacific EZI	Southern Pacific, South America
Noddy	*Anous albivitta*	Grey Noddy	Least Concern	South Pacific EZI	Southern Pacific, South America
Albatross	*Thalassarche chrysostoma*	Grey-headed Albatross	Endangered	South Pacific EZI	Southern Pacific, South America, Australasia
Albatross	*Thalassarche bulleri*	Buller's Albatross	Near Threatened	South Pacific EZI	Southern Pacific, South America, Australasia
Albatross	*Thalassarche melanophris*	Black Browed Albatross	Least Concern	South Pacific EZI	Southern Pacific, South America, Australasia, indian Ocean
Albatross	*Thalassarche eremita*	Chatham Albatross	Vunerable	South Pacific EZI	Southern Pacific, South America, Australasia
Albatross	*Thalassarche salvini*	Salvin's Albatross	Vunerable	South Pacific EZI	Southern Pacific, South America, Australasia, indian Ocean
Shearwater	*Ardenna bulleri*	Buller's Shearwater	Not a specific species	South Pacific EZI	Southern Pacific
Shearwater	*Ardenna carneipes*	Flesh-footed Shearwater	Vulnerable	South Pacific EZI	Southern Pacific
Shearwater	*Ardenna grisea*	Sooty Shearwater	Near Threatened	South Pacific EZI	Southern Pacific
Shearwater	*Ardenna tenuirostris*	Short-tailed Shearwater	Near Threatened	South Pacific EZI	Southern Pacific
Petrel	*Bulweria bulwerii*	Bulwer's Petrel	Least Concern	South Pacific EZI	Southern Pacific
Shearwater	*Calonectris leucomelas*	Streaked Shearwater	Least Concern	South Pacific EZI	Southern Pacific
Skua	*Stercorarius maccormicki*	South Polar Skua	Near Threatened	South Pacific EZI	Southern Pacific
Storm Petrel	*Fregetta tropica*	Black-bellied Storm Petrel	Least Concern	South Pacific EZI	Southern Pacific
Storm Petrel	*Oceanites oceanicus*	Wilson's Storm Petrel	Least Concern	South Pacific EZI	Southern Pacific
Storm Petrel	*Pelagodroma marina*	White-faced Storm Petrel	Least Concern	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma beckii*	Beck's Petrel	Least Concern	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma cervicalis*	White-necked Petrel	Data Deficient	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma leucoptera*	White-winged Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma solandri*	Providence Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Shearwater	*Puffinus huttoni*	Hutton's Shearwater	Vulnerable	South Pacific EZI	Southern Pacific
Skua	*Stercorarius antarcticus*	Brown Skua	Endangered	South Pacific EZI	Southern Pacific
Gull	*Creagrus furcatus*	Swallow-tailed Gull	Least Concern	South Pacific EZI	Southern Pacific
Petrel	*Daption capense*	Cape Petrel	Least Concern	South Pacific EZI	Southern Pacific
Albatross	*Diomedea antipodensis*	Antipodean Albatross	Least Concern	South Pacific EZI	Southern Pacific
Albatross	*Diomedea sanfordi*	Northern Royal Albatross	Endangered	South Pacific EZI	Southern Pacific

Puffin	*Fratercula cirrhata*	Tufted Puffin	Endangered	South Pacific EZI	Southern Pacific
Storm Petrel	*Hydrobates castro*	Band-rumped Storm Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Storm Petrel	*Hydrobates leucorhoa*	Leach's Storm Petrel	Near Threatened	South Pacific EZI	Southern Pacific
Storm Petrel	*Hydrobates tethys*	Wedge-rumped Storm Petre	Vulnerable	South Pacific EZI	Southern Pacific
Storm Petrel	*Hydrobates hornbyi*	White-vented Storm Petrel	Least Concern	South Pacific EZI	Southern Pacific
Albatross	*Phoebastria immutabilis*	Laysan Albatross	Data Deficient	South Pacific EZI	Southern Pacific
Albatross	*Phoebastria irrorata*	Waved Albatross	Near Threatened	South Pacific EZI	Southern Pacific
Albatross	*Phoebastria nigripes*	Black-footed Albatross	Critically Endangered	South Pacific EZI	Southern Pacific
Petrel	*Procellaria aequinoctialis*	White-chinned Petrel	Near Threatened	South Pacific EZI	Southern Pacific
Petrel	*Procellaria cinerea*	Grey Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Petrel	*Procellaria parkinsoni*	Black Petrel	Near Threatened	South Pacific EZI	Southern Pacific
Petrel	*Procellaria westlandica*	Westland Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma atrata*	Henderson Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma cookii*	Cook's Petrel	Endangered	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma gouldi*	Grey-faced Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma inexpectata*	Mottled Petrel	Least Concern	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma mollis*	Soft-plumaged Petrel	Near Threatened	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma neglecta*	Kermadec Petrel	Least Concern	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma phaeopygia*	Galapagos Petrel	Least Concern	South Pacific EZI	Southern Pacific
Petrel	*Pterodroma pycrofti*	Pycroft's Petrel	Critically Endangered	South Pacific EZI	Southern Pacific
Shearwater	*Pterodroma ultima*	Murphy's Petrel	Vulnerable	South Pacific EZI	Southern Pacific
Kittiwake	*Ardenna assimilis*	Little Shearwater	Least Concern	South Pacific EZI	Southern Pacific
Jaeger	*Rissa tridactyla*	Black-legged Kittiwake	Least Concern	South Pacific EZI	Southern Pacific
Jaeger	*Stercorarius longicaudus*	Long-tailed Jaeger	Vulnerable	South Pacific EZI	Southern Pacific
Tern	*Stercorarius pomarinus*	Pomarine Jaeger	Least Concern	South Pacific EZI	Southern Pacific
Albatross	*Sterna paradisaea*	Arcitc Tern	Least Concern	South Pacific EZI	Southern Pacific
Albatross	*Thalassarche impavida*	Campbell Albatross	Vulnerable	South Pacific EZI	Southern Pacific
Murre	*Thalassarche melanophris*	Black-browed Albatross	Near Threatened	South Pacific EZI	Southern Pacific
Murre	*Uria aalge*	Common Murre	Least Concern	South Pacific EZI	Southern Pacific
Gull	*Uria lomvia*	Thick-billed Murre	Least Concern	South Pacific EZI	Southern Pacific
Gull	*Xema sabini*	Sabine's Gull	Least Concern	South Pacific EZI	Southern Pacific

Scientific Name	English Name(s)	Global Conservation Status	Key commercial fish?	Distribution	Habitat	Prey	Breeding	Key Threat (only if applicabl	Source
Pristipomoides filamentosus	Crimson jobfish / Hawaiian pink snapper	Least concern	High commercial value - Deep 7 Bottomfish	Pacific Islands	Deep-water	fish, crustaceans, other invertebrates	June-December, peak in august	Fishing (although sustainable)	NOAA, FishBase, IUCN Redlist,
Etelis carbunculus	Squirrelfish snapper / Ruby snapper	Least concern	High commercial value - Deep 7 Bottomfish	Pacific Islands	Deep-water	fish, crustaceans, other invertebrates	Year-round, peak in November	Fishing (although sustainable)	NOAA, FishBase, IUCN Redlist
Pristipomoides zonatus	Brigham's snapper / Oblique-banded snapper	Least concern	High commercial value - Deep 7 Bottomfish	Pacific Islands	Deep-water	fish, crustaceans, other invertebrates	April -September, peak in August	Fishing (although sustainable)	NOAA, FishBase, IUCN Redlist, Western Pacific Regional Fishery Management Council
Hyporthodus quernus	Seale's grouper / Hawaiian grouper	Least concern	High commercial value - Deep 7 Bottomfish	Pacific Islands	Deep-water	fish, crustaceans, other invertebrates	January-June	Fishing (although sustainable)	NOAA, FishBase, IUCN Redlist, Western Pacific Regional Fishery Management Council
Pristipomoides sieboldii	Von Siebold's snapper / Lavender jobfish	Least concern	High commercial value - Deep 7 Bottomfish	Pacific Islands	Deep-water	fish, crustaceans, other invertebrates	June-September	Fishing (although sustainable)	NOAA, FishBase, IUCN Redlist, Western Pacific Regional Fishery Management Council
Aphareus rutilans	Silverjaw snapper / Rusty jobfish	Least concern	High commercial value - Deep 7 Bottomfish	Pacific Islands	Deep-water	fish, crustaceans, other invertebrates	April -September, peak in August	Fishing (although sustainable)	NOAA, FishBase, IUCN Redlist, Western Pacific Regional Fishery Management Council
Etelis coruscans	Longtail snapper	Least concern	High commercial value - Deep 7 Bottomfish	Pacific Islands	Deep-water	fish, crustaceans, other invertebrates	June-November	Fishing (although sustainable)	NOAA, FishBase, IUCN Redlist, Western Pacific Regional Fishery Management Council
Xiphias gladius	North Pacific swordfish	Neat threatened	High commercial value	Pacific Ocean	Pelagic	fish, invertebrates	Year-round	Fishing	NOAA, FishBase, IUCN Redlist
Lampris guttatus	Opah / Moonfish	Least concern	Some commercial value	Pacific Ocean	Pealgic	fish, invertebrates	Year-round	Fishing, Pollution (Garbage/Solid waste)	NOAA, FishBase, IUCN Redlist
Thunnus obesus	Pacific bigeye tuna	Vulnerable	High commercial value	Pacific Ocean	Pelagic	fish, crustaceans, other invertebrates	Year-round	Fishing	NOAA, FishBase, IUCN Redlist
Coryphaena hippurus	Pacific Mahimahi / Common dolphinfish	Least concern	High commercial value	Pacific Ocean	Pelagic	fish, crustaceans, other invertebrates	Year-round	Fishing	NOAA, FishBase, IUCN Redlist
Katsuwonus pelamis	Pacific skipjack Tuna	Least concern	High commercial value	Pacific Ocean	Pelagic	fish, crustaceans, other invertebrates	Year-round	Fishing	NOAA, FishBase, IUCN Redlist
Acanthocybium solanderi	Pacific wahoo	Least concern	High commercial value	Pacific Ocean	Pelagic	fish, crustaceans, other invertebrates	Year-round	Fishing	NOAA, FishBase, IUCN Redlist
Thunnus albacares	Pacific yellowfin Tuna	Least concern	High commercial value	Pacific Ocean	Pelagic	fish, crustaceans, other invertebrates	Year-round	Fishing	NOAA, FishBase, IUCN Redlist
Kajikia audax	Striped marlin	Least concern	Some commercial value	Pacific Ocean	Pelagic	fish, crustaceans, other invertebrates	September-January	Fishing	NOAA, FishBase, IUCN Redlist, Kopf, R. K., Davie, P. S., Bromhead, D., and Pepperell, J. G. 2011. Age and growth of striped marlin (Kajikia audax) in the Southwest Pacific Ocean. – ICES Journal of Marine Science, 68: 1884–1895.
Alopias vulpinus	Thresher shark	Vulnerable	Low commercial value	East Pacific Ocean	Pelagic	fish	Ovivaporous	Fishing	NOAA, FishBase, IUCN Redlist
Isurus oxyrinchus	Pacific shortfin mako Shark	Endangered	Low commercial value (bycatch in Hawaii)	Pacific Ocean	Pelagic	fish, invertebrates	Ovivaporous	Fishing	NOAA, FishBase, IUCN Redlist
Etrumeus micropus	Pacific round herring	Least concern	High commercial value	Pacific Ocean	Pelagic	planktonivore	Year-round	Fishing	晚夏時期澎湖沿海水域之小鱗脂眼鯡, 之胃內容 and 物組成, 2017. Stomach content analysis of Etrumeus micropus in the coastal waters of Penghu off Taiwan in late summer. Journal of The Fisheries Society of Taiwan, 44(2), pp.135-145.; IUCN Red List; Nyuji, M., Takasuka, A. and Okada, M., 2022. Variation in reproductive parameters of round herring in the Pacific coastal waters of Japan. Journal of Sea Research, 187, p.102247.
Sardinops sagax	Pacific sardine / South American Pilchard	Least concern	High commercial value (fishing prohibited in NOAA districts)	Pacific Ocean, Japan	Pelagic	planktioivore	Summer-Autumn	Fishing, climate change/severe weather	FishBase, IUCN Red List, https://www.fishsource.org/fishery_page/5848
Scomber australasicus	Blue Mackerel	Least concern	High commercial value	Pacific Ocean (coastal)	Pelagic	planktioivore	Unknown, assumed Spring	Fishing	FishBase, IUCN Red List, Sogawa, S., Hidaka, K., Kamimura, Y., Takahashi, M., Saito, H., Okazaki, Y., Shimizu, Y. and Setou, T., 2019. Environmental characteristics of spawning and nursery grounds of Japanese sardine and mackerels in the Kuroshio and Kuroshio Extension area. Fisheries Oceanography, 28(4), pp.454-467.

Appendix 11 -

aurora

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