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British Antarctic Survey

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TABLE OF ABBREVIATIONS

Term	Abbreviation
(Abbreviated) Precision Approach Path Indicators	(A)PAPI
Alternating Current	AC
Antarctic Conservation Biogeographic Region	ACBR
Antarctic Circumpolar Current	ACC
Airfield Ground Lighting	AGL
Atmosphere, Ice and Climate	AIC
Antarctic Infrastructure Modernisation Project	AIMP
Above Sea Level	ASL
Antarctic Specially Protected Area	ASPA
Antarctic Treaty Secretariat	ATS
Aviation Carrier Turbine Fuel	AVCAT
Aviation Turbine Fuel	AVTUR
BAM Nuttall	BAM
British Antarctic Survey	BAS
Biodiversity, Evolution and Adaptation	BEA
Building Integrated Solar PV	BIPV
Building Management System	BMS
Building Research Establishment Environmental Assessment Method	BREEAM
California Bearing Ratio	CBR
Climate Change Resilience	CCR
Comprehensive Environmental Evaluation	CEE
Committee for Environmental Protection	CEP
Combined Heat and Power	CHP
Carbon Dioxide	CO_2
Conductivity, Temperature and Depth	CTD
Environment Agency	EA
East Beach Hut	EBH
Environmental Impact Assessment	EIA
Electromagnetic Interference	EMI
Future Aircraft Capability	FAC
Foreign, Commonwealth and Development Office	FCDO
Greenhouse Gas	GHG
Ground Investigation	GI
Global Sea Level Observing System	GSLOS
Government Soft Landings	GSL
Healthy and Safety	H&S
Historical Sites and Monuments	HSMs
Important Bird and Biodiversity Area	IBA
Initial Environmental Evaluation	IEE
Interim Waste Handling Facility	IWHF
Key Performance Indicators	KPI
Mechanical and Electrical	M&E
modified Circumpolar Deep Water	mCDW
Mobile Elevation Working Platform	MEWP
Marine Gas Oil	MGO
New Bransfield House	NBH
Normalised Difference Vegetative Index	NDVI
Natural Environment Research Council	NERC
Non-Directional Beacon	NDB
Non-Native Species	NNS
Old Bransfield House	OBH
Oil Spill Contingency Plan	OSCP
Open Top Chamber	OTC
Peak Particle Velocity	PPV
Preliminary Environmental Assessment	PEA

Term	Abbreviation
Personal Protective Equipment	PPE
Particle Size Analysis	PSA
Post Season Environmental Report	PSER
Photovoltaic	PV
Plant Management Plan	PMP
Project Variation Register	PVR
Rothera Time Series	RaTS
Runway End Identifier Lighting	REIL
Runway Entrance Lights	REL
Renewable Energy Activities	RENEW
Rothera Modernisation Project	RMP
Reverse Osmosis	RO
Remotely Operated Vehicle	ROV
Rothera Station Integration Plan	RSIP
Runway Resurfacing and Lighting	RUNSUR
Sustainability Assurance Group	SAG
Systeme d'Analyse par Observations Zénithales	SAOZ
Sir David Attenborough (Royal Research Ship)	SDA
Sustainable Development Goals	SDG
Site Investigation	SI
Sustainability Management Plan	SMP
Standard Operation Procedure	SOP
Sewage Treatment Plant	STP
Space Weather and Atmosphere	SWA
Site Waste Management Plan	SWMP
Site Wide Services	SWS
Total Suspended Particle	TSP
United Kingdom Antarctic Heritage Trust	UKAHT
UK Research and Innovation	UKRI
United Nations	UN
Ultraviolet	UV
Vibration Dose Values	VDV
Very Low Frequency	VLF

NON-TECHNICAL SUMMARY

Introduction

The Antarctic Infrastructure Modernisation Project (AIMP) is a long-term infrastructure upgrade of the British Antarctic Survey (BAS) facilities across the Antarctic and South Atlantic. The project is part of a 10–15-year programme of works upgrading Rothera Research Station, BAS' largest facility supporting climate, biodiversity, and ocean research in the Antarctic region.

The Antarctic Infrastructure Modernisation Project (AIMP) aims to provide a station that is fit for purpose for the next 25 years, as outlined within the Rothera Modernisation Master Plan Report (2017). In March 2021, the Master Plan Report was updated to reflect the progress and changes to Rothera since 2017. The Master Plan therefore sets out how the Rothera Modernisation Project will achieve ambitions for a research station that is resilient, flexible, and fit for the future.

The AIMP for Rothera currently encompasses two overarching phases.

Phase 1:

- WHARF: Upgrading the Rothera Wharf, completed in 2020 and assessed under the Rothera Wharf Reconstruction and Coastal Stabilisation Comprehensive Environmental Evaluation (CEE), and supporting Preliminary Environmental Appraisal (PEA); and
- RMP: Construction of the new Discovery Building alongside Site Wide Services Installation (assessed under the 2019 Rothera Modernisation Phase 1 Initial Environmental Evaluation (IEE)), the latter of which is currently being constructed, with anticipated completion in April 2025.

Phase 2:

- HANGAR: Refurbishing/replacing the Aircraft Hangar;
- RENEW: Renewable energy installations at Rothera to support BAS & UKRI Net Zero targets; and
- RUNSUR: Resurfacing and upgrading of the runway (assessed under the 2022 Rothera Runway Resurfacing and Lighting, Site Investigation And Condition Survey Works Initial Environmental Evaluation),

The scope of this IEE covers scope changes and snagging items that have arisen over the course of the AIMP programme and are necessary to handover and complete the RMP Discovery Building and Sitewide Services as well as the Phase 2 RUNSUR project. The scale of these scope changes is considered likely to have a no more than minor or transitory impact on the Antarctic environment and therefore an IEE has been prepared.

Any future phases of the AIMP are not yet scoped in detail and are yet to be funded.

This IEE has been prepared by Ramboll UK Ltd on behalf of BAS. It should be noted, however, that this final revision includes updates from BAS.

Article 8 of the Protocol on Environmental Protection to the Antarctic Treaty 1991, requires that any activities in the Antarctic Treaty shall be subject to an assessment, in accordance with the procedures set out in Annex I to the Environmental Protocol, Environmental Impact Assessment (EIA).

The information provided here aims to facilitate the approval of the works – as described in this IEE - by the Foreign, Commonwealth and Development Office (FCDO), the UK competent authority.

Overview of Proposed Works

The proposed works over the next 2 Seasons at Rothera have been referred to as the AIMP 2024-2025 and 2025-2026 projects.

Over the course of the 2024 – 2025 and 2025 – 2026 Seasons, several activities that were not completed in previous seasons will be undertaken. These activities have already been assessed and approved within previous PEAs and/or IEEs, by either the FCDO or BAS Environment Office acting under delegated authority from the FCDO. Where the proposed methodologies for these activities remain unchanged as approved, these are referred to as 'Previously Assessed Activities'.

In addition, there are also several proposed activities for the 2024 – 2025 and 2025 – 2026 Seasons which have been approved in previous PEAs and/or IEEs but have since been subject to changes in their original scope. To ensure any changes in the methodology or impact of the activity have been captured, these activities have been reassessed within this IEE and are referred to as 'Previously Assessed Activities with Scope Changes'.

Finally, there are proposed activities which are new to the 2024 – 2025 and 2025 – 2026 Seasons that have not been assessed in any previous EIA – these are referred to as 'New Activities'.

Section 3.3 contains further detail on these activities, including whether they have been previously assessed (and if so in which document), or if they are new, how they will be assessed within this IEE. The proposed works over the next 2 seasons at Rothera are listed below:

Previously Assessed Activities

Future Aircraft Capability (FAC)

- California Bearing Ratio (CBR) Measurement testing of the runway; and
- Friction testing of the runway.

RUNSUR

- Installing Non-Engineered Slipways adjacent to the runway.

HANGAR

- Ground Investigations to support the Hangar foundation design.

WHARF

- Installation of six mooring weights on the Wharf to support small boat activities.

RMP

- Repairs to sitewide services to resolve structural damage caused by snow loading;
- Earthing the Discovery Building and installing a vehicles fuel tank adjacent to the Building; and
- Installation of the Discovery Building wind deflector, completing the sitewide service routes, and internal finishing works ahead of the Discovery Building handover in April 2025.

Previously Assessed Activities with Scope Changes

RENEW

- Installing a solar monitor west of the runway; and
- Non-intrusive building condition surveys to assess solar PV suitability.

RMP

- Connecting Admirals and Discovery Buildings to the STP Drainage Installation;
- Strip out and deconstruction of 6 existing buildings at Rothera; and
- Removal and containerisation of Waste from Rothera including Biscoe Wharf waste, and the removal of containers from Rothera at the end of the RMP project.

RUNSUR

- Removal of Processed Aggregate from the area south of the Hangar

New Activities

VLF

- Relocating the Very Low Frequency (VLF) Equipment to a hut on the East Beach of Rothera following the transfer of power services to Discovery Building.

RUNSUR

- Managing defects including potholes and subsidence on the runway that have arisen in the 2023-2024 Season;
- Defrosting and waterproofing frozen chambers underneath the runway; and
- Processing previous trench-dug material to stockpile for future runway maintenance.

RMP

- Remedial works to amend frozen ducts;
- Drainage installation and connection to Sewage Treatment Plant;
- Re-routing the Sitewide Services at selected locations:
    - BAM Fitters Workshop to Waste Handling Facility
    - Vikings House to Bentham Container
    - Bonner Laboratory to Gerritsz Laboratory
    - Bentham Communications Container to ARIES Dome
- Installing an external concrete slab to the north yard of Discovery;
- Reprofiling the road between Admirals and the Runway Crossing; and
- Creating a temporary south access road to Discovery Building while north yard works occur.

WHARF

- Site Investigations for a potential new Mooring Point for the RRS Sir David Attenborough.

In addition to the above projects, support activities that are essential to enable the delivery of the proposed works are included as part of this assessment, including:

- Shipping cargo to and from Rothera;
- Transport of personnel to and from Rothera;
- Storage of cargo;
- Site set-up and presence of personnel;
- Vehicle, plant, and equipment operation;
- Fuel management and refuelling;
- Sterilisation of potable water systems;
- Flushing/cleaning of Low Temperature Hot Water (LTHW) systems;
- Provision of accommodation, power, and domestic services;
- Transport of materials across Rothera;
- Removal of waste from Rothera via vessel; and
- Crane winterisation.

The proposed works are anticipated to be completed over the 2024–2025 and 2025–2026 Seasons commencing in November 2024 and ending in April 2026, works include some resource presence in austral winter 2025 to complete the internal fitout of the Discovery Building.

Description of Site and Environment

Rothera is located on the south-eastern shore of Adelaide Island on the Antarctic Peninsula and has been used operationally on a continuous basis since 1975. Rothera was initially planned and constructed in phases which meant that infrastructure development was undertaken as operational requirements and demands changed.

Environmental constraints at Rothera include existing buildings, heritage assets, surface water features, vegetation (including the moss patch), the ice ramp, operational hazard zones, skua nests, local glaciology, and communications instruments.

Rothera is largely ice free which is relatively rare for Antarctic sites. Rothera contains some examples of Antarctic fellfield environments, which are reasonably rare in the wider area. There is a patch of continuous moss to the north-east of the Discovery Building. As such, the vegetation on Rothera is considered to be of outstanding value. As far as is known, the terrestrial invertebrate fauna on Rothera is impoverished. South polar skuas (*Stercorarius maccormicki)* are the most abundant breeding bird on Rothera and their populations have been monitored annually since 1988. Other species such as penguins, seals and whales are occasionally observed in the area. No non-native plants or invertebrates are known to be present on Rothera or in the adjacent marine environment.

An area to the north-east of Rothera Point is designated as an Antarctic Specially Protected Area (ASPA) to protect scientific values and serve as a control area against which the effects of human impacts can be monitored. This designation is unique as it is the only protected area currently designated solely for its value in monitoring human impacts.

The proposed works are within the footprint of existing infrastructure at Rothera and are largely on previously disturbed ground. The key environmental receptors which are most likely to be potentially impacted by the proposed works are terrestrial flora and fauna and local glaciological features.

Assessment of the Environmental Impacts

The approach taken when compiling this EIA followed the Antarctic Treaty Secretariat EIA Guidelines prepared by the Committee for Environmental Protection alongside existing BAS IEE methodologies. The guidelines provide advice and recommendations on appropriate document structure as well as methodologies for identifying and evaluating impacts.

The EIA has followed a four-step process involving:

- Identifying the proposed activities of the project;
- Identifying the environmental aspects – the way in which any of the proposed activities interact with the environment such as atmospheric emissions, dust, noise, fuel spills, waste introduced, risk of non-native species etc.;
- Identifying the potential environmental impact – the change in environmental value or resource as a result of the activity; and
- Assessing the significance of the identified impact – considering the spatial extent, duration, probability of occurrence and severity of the potential impact on the environment with reference to the three levels of significance identified by Article 8(1) of the Environmental Protocol i.e., less than, no more than or more than a minor or transitory impact.

A full assessment of the potential environmental impacts, including any cumulative impacts with other activities at Rothera, are included in this IEE. For the purposes of the assessment of potential impacts, the activities of the proposed works have been divided into categories based on the nature of the works, summarised here:

- Construction activities;
- SI works and condition surveys (intrusive and non-intrusive);
- Monitoring activities; and
- Support activities.

This IEE has incorporated activities that have been previously assessed in other environmental assessments but were not undertaken as intended. Where this is the case, these activities are not re-assessed using the methods as outlined in the approach above but have been considered as cumulative effects in conjunction with the activities that are in scope for this IEE.

Environmental Aspects

Potential impacts of the identified activities have been presented for each environmental aspect, where relevant, and key mitigation and / or monitoring requirements briefly described.

Atmospheric emissions associated with most activities within the four categories assessed have the potential to contribute to global atmospheric pollution, as well as heavy metal and particulate fallout locally. Mitigation measures are in place to ensure that all operations are as efficient as possible to reduce excess fuel use, alongside the exploration of alternative fuels.

Noise and vibration emissions associated with most activities within the four categories assessed have the potential to impact local fauna, potentially resulting in avoidance or stress behaviour and / or nest abandonment. A slow-start procedure will be implemented for all noisy construction and survey equipment such as the use of power tools and large machinery. Noise and vibration monitoring takes place at agreed locations at Rothera, and if agreed noise or vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented. Any noise and/or vibration exceedances will be reported on Maximo.

Dust emissions associated with most construction activities, SI and condition surveys, and support activities assessed have the potential to affect local flora and fauna and glaciological features due to dust deposition. The weather forecast will be reviewed every morning to inform the decision of which activities can proceed that day and if any activities need to be suspended or additional mitigation measures put in place. Dust monitoring takes place at agreed locations at Rothera, and if agreed dust levels are exceeded, works in that area will cease until additional mitigation measures can be implemented. Any dust exceedances will be reported on Maximo.

Waste generation associated with some construction activities and support activities assessed have the potential to impact on UK landfill capacity. There is also a risk of waste being released into the local environment (i.e. wind-blown). For all construction waste the Site Waste Management Plans (SWMP) for the projects will be followed which set out the aim to achieve an 80% diversion of construction waste from landfill and a 90% diversion of all waste from landfill. The SWMPs set out that wherever possible, the production of waste material on site will follow the ‘reduce, reuse, recycle, recover’ hierarchy. All excavated material will be reused at Rothera, and all construction waste materials are offered to the Station Manager for reuse within the station to reduce the carbon impact of transporting waste back to the UK.

Light emissions associated with most construction activities, monitoring activities and most support activities assessed have the potential to increase the risk of disturbance to local fauna and could potentially lead to increased bird strikes, injuries, and fatalities. Works will be undertaken during daylight hours as far as reasonably possible, and any bird strikes will be recorded on the BAS Incident Reporting System (Maximo) for monitoring and management purposes.

Physical presence and use of space associated with most activities within the four categories assessed has the potential to impact all ongoing operations at Rothera, day-to-day station operations and hamper good housekeeping. Construction, survey, and sampling locations will be confined to agreed areas and all works programmes will be communicated clearly. A Rothera Station Integration Plan will be prepared to demonstrate adequate space on site for the proposed activities.

Physical or mechanical disturbance on land associated with all construction activities, some SI and condition survey activities, and some support activities assessed are likely to cause ground disturbance as a result of intrusive works as well as the deterioration of existing roads at Rothera. This is mitigated by minimising the footprint of works and locating intrusive SI away from sensitive environmental receptors through careful design.

Fuel or hazardous substance release associated with most construction activities, some SI and condition survey activities and some support activities assessed have the potential to impact the local terrestrial and marine environment. Pollution incidents could result in mortality to flora and fauna and secondary contamination if animals or birds ingest any contaminated material. The Oil Spill Contingency Plan will be followed for all spills and there will be pre-deployment and on-site training for staff. Any environmental incidents in relation to fuel or hazardous substance release will be reported on Maximo.

Non-native species introduction is associated with the support activities assessed as these activities bring cargo, equipment, and staff to site. Introduced species may become established with negative impacts upon local ecosystem structure and function, endemic species and associated scientific research. All support activities will be undertaken in accordance with the BAS Biosecurity Regulations, the Committee for Environmental Protection (CEP) Non-Native Species Manual and the Project-Specific Biosecurity Plan(s). Any environmental incidents in relation to non-native species introduction will be reported on Maximo.

Disturbance to native flora and fauna associated with all construction activities, some SI and condition survey activities and some support activities assessed have the potential to affect local flora and fauna through habitat loss, disturbance, injury, or fatality. This includes marine mammals, marine benthic communities and birds and could result in avoidance or stress behaviour, nest abandonment and hearing damage. The BAS Wildlife Handling Manual will be referred to for any contact with wildlife, and specific mitigation measures will be introduced where required. Skua monitoring will continue and the demarcation of no-go-zone around the moss patch will be maintained. The disturbance to native flora and fauna will be mitigated through measures such as siting of activities away from sensitive receptors, a slow-start methodology, sensitive lighting, speed limiting, and pollution prevention detailed within this IEE. Any environmental incidents in relation to native flora and fauna disturbance, including bird strikes as mentioned previously, will be reported on Maximo.

Visual impacts associated with most construction activities, some SI and condition survey activities and some support activities assessed have the potential to impact the built and natural landscape at Rothera by changing the visual and local aesthetic values of the surrounding landscape. To mitigate visual impacts, all activities will be confined to agreed areas on site and any changes to these locations will be discussed and agreed with the Rothera Station management team, and where appropriate the BAS Environment Office and FCDO.

Climate change has been considered as part of this IEE, both in terms of contribution and resilience to the effects of global climate change. While atmospheric emissions will arise as a result of the four activities assessed during the 2024 – 2025 and 2025 – 2026 Seasons, notably the support activities, these effects are considered to be unavoidable due to the remote location of Rothera. In addition, the four categories of activities are not considered to be significantly susceptible or vulnerable to the effects of climate change, both in the short-term during construction and in the medium-term operationally. Therefore, the construction and operation of VLF, RENEW, RMP, WHARF and the Hangar activities in the medium-term are considered to be climate resilient.

Cumulative impacts have been assessed for all activity categories include within this IEE. This assessment has considered interaction with ongoing activities, including BAS Estates activities, along with the overlap with the Discovery Building construction programme with the scope of this IEE. Activities that have been assessed and consented (either through PEA or IEE) but were not undertaken as planned, have been considered within the cumulative impacts section of this IEE to establish a full view of all works taking place throughout the assessment period. When combined, these activities have the potential to increase impacts to the environmental aspects covered within this IEE. The mitigation and monitoring proposals outlined in the IEE have been considered with cumulative effects in mind and are considered to be sufficient to manage the potential cumulative environmental impacts that could arise.

Alternatives and the 'Do Nothing' approach have been assessed for the 'Previously Assessed with Scope Changes' and 'New Activities'. This assessment considers the need for each activity and whether a less environmentally impactful option, 'alternatives', could be deployed, or whether the project needs to be completed at all, 'do nothing'. A summary of each activity is given in Section 6.

Monitoring and Audit Requirements

Monitoring activities will be undertaken during the 2024-2025 and 2025-2026 Seasons, and will include monitoring of wildlife displacement, moss patch condition, neutralisation of cement and grout contaminated waters, as well as monitoring of noise, vibration, and dust at selected locations. Monitors for noise and vibration, and dust will be hardwired to the BAS IT system and transferred to Rothera office via the Rothera virtual local area network (VLAN) to provide real time data. Real time data collection will allow BAS and BAM to understand the cause of any exceedances, which can then be actioned to mitigate the potential environmental impact within a suitable time frame if required.

Following issues with monitors in the 23/24 season, a number of actions have been taken to improve the environmental monitoring on site including:

- Recalibration of 4 No. dust monitors, 4 No. microphones and 4 No. vibration sensors to be used in the coming season. These have all shown no signs of malfunction.
- All 4 monitors having been set up in the UK for trialling pre-season, with the BAM environmental management staff who will be on station within the season in attendance.
- Additional environmental resource has been allocated on site to ensure that exceedances, as well as other environmental issues, are properly reported and addressed.
- A target date of 16th November has been set for all environmental monitors to be installed and operational on site, following snow clearing between 4-16th November. It should be noted that this target date is dependent on the amount of snow found on site (see *Gaps in Knowledge and Uncertainties* below).

Monitoring of skua breeding success is a long-term monitoring activity and will continue.

An environmental audit programme will be undertaken during the construction works by an appropriate staff member or site supervisor to ensure that the actions and mitigation measures committed to in this document are being adhered to. This audit will follow a BAS Environment Office approved checklist.

Gaps in Knowledge and Uncertainties

Exact timings of the works are not available for all activities, and where these are not available assumptions have been made or it is stated that these activities will take place at some point within the 2024-2025 and 2025-2026 Seasons. Any deviations to the information presented within this IEE will be accounted for within a Project Variations Register (PVR); a live document that is actively managed and owned by BAS in close collaboration with BAM personnel in Rothera. Any variations will be reported in the Post Season Environmental Report, along with a full complement of the monitoring data collected in support of the works that season.

Monitoring equipment is often not able to be set-up immediately upon arrival at Rothera due to the snow clearance requirements. The absence of monitoring equipment is therefore acknowledged as a risk. The steps listed above have been taken to mitigate as far as possible the failure of monitoring equipment, with a target date of 16th November to set up all environmental monitors on site. It should be noted that this target date is dependent on the amount of snow on site, if excessive snow is present on site at the start of the season, additional snow clearing will be required and the 30th November is the latest date the monitors will be installed and operational. Monitoring equipment MUST be in place prior to construction activities commencing, to avoid major risks associated with environmental disturbance and reporting.

The funding and full scope of future phases of the AIMP has not yet been confirmed and will be considered in future EIAs, as appropriate.

Conclusions

The most likely potential impacts anticipated for all four of the activity categories assessed within this IEE are:

- Introduction of non-native species;
- Cumulative noise impacts due to overlapping construction periods with the Discovery Building, as well as other Rothera activities;
- Dust deposition on the ice ramp and impacts to local flora and fauna through inhalation and smothering;
- Physical presence, use of space and disturbance to science activities and day-to-day operations;
- Physical and / or mechanical disturbance to land as a result of intrusive groundworks; and
- Terrestrial (and potentially marine) pollution from fuel spills.

Having prepared this IEE along with specific mitigation measures to reduce the risk of the potential impacts occurring, alongside a thorough monitoring and auditing proposal, it is considered that the proposed works will have no more than a minor or transitory impact.

1. INTRODUCTION

1.1 Introduction

The Antarctic Infrastructure Modernisation Project (AIMP) is a long-term infrastructure upgrade of the British Antarctic Survey (BAS) facilities across the Antarctic and the South Atlantic. The AIMP represents the largest UK Government investment in polar science since the 1980s and will enable BAS to continue to deliver world leading science capability in the Polar Regions, delivering critical new and updated buildings and a new energy infrastructure. BAS have appointed the engineering consultancy Ramboll UK Limited (Ramboll) as the Technical Advisors for the project and BAM Nuttall (BAM) have been contracted as the Construction Partner, who in turn are partnered with design consultants Sweco UK.

This project is part of a 10-15 year programme of works upgrading Rothera Research Station (hereafter referred to as 'Rothera'), see Figure 1-1, BAS' largest facility supporting climate, biodiversity, and ocean research in the Antarctic region. The Rothera Modernisation Project (RMP), which is part of AIMP, aims to provide a station that is fit for purpose for the next 25 years. In 2017, a Rothera Modernisation Master Plan Report was developed for Rothera, detailing the developments planned for Rothera over the next 25 years.

In March 2021, the Master Plan Report was updated to reflect the progress and changes to Rothera since 2017, setting out how the RMP will achieve ambitions for a research station that is resilient, flexible, and fit for the future.

Figure 1-1 Rothera Research Station on Adelaide Island.

As part of the Master Plan's potential future development strategy for Rothera, the AIMP for Rothera currently encompasses two overarching phases, which require environmental assessments when planned activities are known and understood in sufficient detail.

An Initial Environmental Evaluation (IEE) was produced in 2019 for selected activities of the AIMP, titled the 'Rothera Modernisation Phase 1 IEE'[1] (hereafter the 'RMP IEE 2019'). An IEE was also produced in 2022 for the Rothera RUNSUR, Site Investigation (SI) and Condition Survey Works for Phase 2 works[2] (hereafter the 'RUNSUR IEE 2022'), however not all the Phase 2 activities listed below were included in the IEE produced in 2022.

1.1.1 Phase 1

- Upgrading the Rothera Wharf to be suitable for the mooring of the Royal Research Ship Sir David Attenborough (SDA) (Rothera Wharf Reconstruction and Coastal Stabilisation CEE[3]); and
- Construction of the new Discovery Building (previously referred to as the 'Operations Building' in the RMP IEE 2019). The Discovery Building will provide upgraded office, storage, and maintenance facilities, alongside Site Wide Services (SWS) Installation. It is currently in the construction phase, with anticipated initial handover scheduled for April 2025.

1.1.2 Phase 2

- Rothera runway resurfacing and upgrades, including an extension to accommodate a new aircraft (as previously assessed in the RUNSUR IEE 2022);
- Refurbishment of the existing Hangar, or construction of a new Hangar to facilitate the new aircraft; and
- Renewable energy infrastructure to contribute to the Rothera 2030 zero carbon strategy;

The funding and full scope of any future phases, beyond Phase 2, have not yet been confirmed and will be considered in future environmental impact assessments (EIA), as appropriate and when detailed activity scopes are available.

This IEE has been prepared by Ramboll UK Ltd on behalf of BAS to assess the potential environmental impacts associated with selected activities of Phase 2 of the AIMP. It should be noted, however, that this final revision includes updates from BAS. The information provided in this report aims to facilitate the approval of the proposed works at Rothera – as described below - by the FCDO, the UK competent authority.

1.2 Overview of Proposed Activities

The proposed activities covered in this IEE have been referred to collectively as the 'AIMP 2024-2025 and 2025-2026 Projects IEE'. This IEE assesses the potential impacts of the proposed construction, SI and condition survey, monitoring, and support activities, to inform several of the redevelopment and modernisation aspirations listed above.

The scope of this IEE includes selected activities of the AIMP Phase 2 as listed within Section 3 which have been divided into the following six projects:

- RENEW
- HANGAR
- WHARF
- RMP
- Runway Resurfacing and Lighting (RUNSUR)
- Very Low Frequency (VLF) Equipment Relocation

[1] British Antarctic Survey (BAS) Environment Office, 2019. BAS Antarctic Infrastructure Modernisation Programme. Rothera Modernisation - Phase 1 Initial Environmental Evaluation. [Online] Available at: https://www.bas.ac.uk/wp-content/uploads/2019/11/Rothera-Modernisation-Phase-1-IEE-Final.pdf

[2] British Antarctic Survey (BAS) Environment Office, 2022. Initial Environmental Evaluation for Rothera Runway Resurfacing and Lighting, Site Investigation and Condition Survey Works. [Online] Available at: BRITISH ANTARCTIC SURVEY (bas.ac.uk)

[3] British Antarctic Survey (BAS) Environment Office, 2018. Rothera Wharf Reconstruction & Coastal Stabilisation: Final Comprehensive Environmental Evaluation. [Online] Available at: Microsoft Word - Final CEE Rothera Wharf Reconstruction & Coastal Stabilisation 05.09.18.docx (bas.ac.uk)

A detailed scope of activities is provided in Section 3.4 and methodologies for each of the proposed activities are set out in Section 4.

In order to facilitate the above projects, other support activities will also be undertaken prior to and alongside the Phase 2 activities, including:

- Vehicle, plant, and equipment operation;
- Shipping cargo to and from Rothera;
- Transport of personnel to and from Rothera;
- Provision of accommodation, power, logistical and domestic services;
- Site set-up and presence of personnel;
- Fuel management and refuelling;
- Flushing/Cleaning of LTHW systems;
- Sterilisation of the Potable Water system;
- Transportation of construction materials and new structures across Rothera;
- Stockpile management;
- Survey Control Point Installations; and
- Crane winterisation.

Project specific support activities include:

- Removal of waste via a commercial vessel in March 2026: the vessel will remove waste from Rothera to take to the UK for processing and disposal. This would also include legacy waste from the past Biscoe Wharf, the deconstruction of which was approved and completed as part of the 'Rothera Wharf Reconstruction and Coastal Stabilisation – Final CEE 2018'; and
- Removal of rock / soil samples from Rothera to the UK for testing.

Further activities required to support AIMP Phase 2 will be captured and assessed in future EIAs when preferred design options and associated construction methodologies are known.

1.3 Purpose and Scope of Document

This IEE has been prepared in accordance with the requirements of Article 3 of Annex I to the Protocol on Environmental Protection to the Antarctic Treaty (1991)[4] (hereafter referred to as 'the Environmental Protocol') to provide sufficient information on the scope of works, for an informed judgement to be made on the possible environmental impact of these activities on the Antarctic environment, as well as whether they should proceed.

The scope of this IEE covers the works listed above. Other development works which may be undertaken at Rothera in the future but have not yet been fully scoped, designed, or funded are not included in this assessment. Such future initiatives have however been outlined in Chapter 14: Gaps in Knowledge and Uncertainties.

This document comprises the following chapters:

- Chapter 1 introduces the proposed project;
- Chapter 2 provides the approach to the EIA;
- Chapter 3 describes the proposed development including the need, location, and scopes;
- Chapter 4 outlines the construction, SI and condition survey, and monitoring activities methodologies;
- Chapter 5 describes the support activities required to facilitate the projects;
- Chapter 6 describes the alternatives considered for the proposed activities;
- Chapter 7 outlines the operational procedures that will be followed;
- Chapter 8 outlines the programme of activities;
- Chapter 9 presents a description of the site, including location, site history and current uses;

[4] Antarctic Treaty Consultative Parties, 1991. Article 3 of Annex I to the Protocol on Environmental Protection to the Antarctic Treaty.

- Chapter 10 presents the current environmental baseline conditions;
- Chapter 11 provides the assessment of environmental risks (including scoring) and potential impact associated with the proposed activities, mitigation and monitoring measures, and any cumulative activities identified;
- Chapter 12 presents the monitoring and audit requirements;
- Chapter 13 provides the gaps in knowledge and uncertainties; and
- Chapter 14 provides the conclusions of this IEE.

1.4 Contact Details

Further information on this IEE can be obtained from:

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2. APPROACH TO ENVIRONMENTAL IMPACT ASSESSMENT

2.1 Statutory Requirements

To ensure the protection of the Antarctic environment, the Antarctic Treaty nations adopted the Environmental Protocol. The UK enforces the provisions of the Environmental Protocol through the 'Antarctic Act 1994'[5], the 'Antarctic Act 2013'[6], and the 'Antarctic Regulations 1995/490 (as amended).[7]

Article 8 of the Environmental Protocol requires that any activities in the Antarctic Treaty shall be subject to an assessment, in accordance with the procedures set out in Annex I to the Environmental Protocol, EIA.

One of the guiding principles is that an EIA be carried out before any activity is allowed to proceed. Activities should be planned and conducted based on '*information sufficient to allow prior assessments of, and informed judgements about, their possible impacts on the Antarctic environment*' (Article 3, Environmental Protocol).

Annex I to the Environmental Protocol sets out the detailed requirements for EIA in Antarctica and establishes three assessment levels based on different levels of predicted impact. The assessment levels are:

- Preliminary Stage (represented at BAS by the Preliminary Environment Assessment or PEA);
- Initial Environmental Evaluation (IEE); and
- Comprehensive Environmental Evaluation (CEE).

If an activity is determined, based on a completed Preliminary Stage, as having less than a *minor or transitory* impact, the activity may proceed. An IEE must be prepared if it is determined that an activity will have an impact equal to or no more than *minor or transitory*. A CEE is required for activities that are likely to have more than a *minor or transitory* impact on the Antarctic environment.

Following the EIA process as outlined in Annex I and in agreement with the UK FCDO, it is concluded that an IEE is the appropriate level of assessment for the scope of works outlined in Section 3.2.

It is acknowledged that EIA best practice is to take a holistic approach for multiple developments. However, the AIMP spans several infrastructure development projects which are intended to be funded and constructed over a period of at least 10 years. The most recent of these was the Rothera Runway Resurfacing and Lighting works (RUNSUR) which commenced during the 2022 – 2023 Season and was successfully completed in the 2023 – 2024 Season. Concurrently, the construction of the new Discovery Building was ongoing as part of AIMP Phase 1, which commenced in 2020, with anticipated handover in April 2025. An IEE was produced and approved for that project in 2019. Cumulative impacts of all AIMP and BAS Estates and business as usual works coinciding with the proposed activities set out in this document have been addressed where possible within the cumulative impacts assessment. The activities in this assessment will also be assessed cumulatively in any future EIA submission for further works at Rothera that may take place concurrently within the 2024-2025 and 2025-2026 Seasons, if required.

This IEE is to be made publicly available on both the BAS website[8] and the Antarctic Treaty Secretariat (ATS) EIA database[9].

[5] UK Legislation, 2024. Antarctic Act, 1994, online. Available at: Antarctic Act 1994 (legislation.gov.uk)
[6] UK Legislation, 2024. Antarctic Act, 2013, online. Available at: Antarctic Act 2013 (legislation.gov.uk)
[7] UK Legislation, 2022. The Antarctic Regulations, 1995 No. 490, online. Available at: The Antarctic Regulations 1995 (legislation.gov.uk)
[8] BAS, 2024. EIAs for proposed activities in Antarctica prepared by the UK. [Online] Available at: https://www.bas.ac.uk/about/antarctica/environmental-protection/environmental-policy-and-management/environmental-impact-assessments-eias-in-antarctica/eias-for-proposed-activities-in-antarctica-prepared-by-the-uk/
[9] Secretariat of the Antarctic Treaty, 2024. EIA Database. [Online] Available at: https://www.ats.aq/devAS/EP/EIAList?lang=e

2.2 EIA Methodology

The approach taken when compiling this EIA follow the CEP EIA Guidelines 2016[10]. The guidelines provide advice and recommendations on appropriate document structure as well as methodologies for identifying and evaluating impacts.

Accordingly, this EIA has followed a four-step process comprising:

- Identifying the proposed activities of the project;
- Identifying the environmental aspects – the way in which any of the proposed activities interact with the environment, such as atmospheric emissions, dust, noise, fuel spills, waste, introduced non-native species etc;
- Identifying the environmental impact – the change in environmental value or resource as a result of the activity; and
- Assessing the significance of the identified impact – considering the spatial extent, duration, probability of occurrence and severity of the potential impact on the environment with reference to the three levels of significance identified by Article 8(1) of the Environmental Protocol i.e., less than, no more than or more than a minor or transitory impact.

Other previously published IEEs and CEEs have been used as sources of information on the potential environmental impacts of activities within Antarctica, including example approaches of assessment of activities and impacts, as well as appropriate mitigation measures to manage potential environmental impacts. This includes the most recent RUNSUR IEE 2022, covering activities undertaken in the 2022 - 2023 and 2023 - 2024 Seasons.

Baseline information on the current environmental state at Rothera has been included to evaluate the potential impacts effectively. This information was largely sourced from scientific experts within BAS and includes recent work by BAS scientists to update the environmental baseline.

The scope and nature of the activities and a description of the principal characteristics of the AIMP Phase 2 activities have been provided in Chapters 3-6. Design and construction details have been provided collaboratively by BAS, BAM (as the Construction Partner) and Ramboll Engineers (as the Technical Advisory Team).

A more detailed explanation of the assessment methodology is outlined in Chapter 11.

Chapter 11 also presents the possible impacts identified, as well as measures to mitigate, or to prevent them from occurring. As suggested by the CEP's EIA guidelines, and successfully used in previous EIAs, a matrix format has been used to evaluate the significance of the identified impacts. Direct, indirect, cumulative, and unavoidable impacts have been examined and are ranked according to their extent, duration, probability, and significance. A risk rating has been applied to each impact before and after mitigation.

The potential impacts have been predicted using professional opinion and the experience of the Ramboll EIA team, individual BAS scientists and the BAS Environment Office. Environmental monitoring is undertaken by BAM throughout the season at agreed locations at Rothera to monitor noise, vibration and dust levels associated with BAM construction activities. The outcomes of a review of environmental monitoring in 2023 - 2024 by BAS, and monitoring locations for the upcoming season, have been provided in Chapter 13.

[10] CEP, 2016. Guidelines for Environmental Impact Assessment in Antarctica, online. Available at: https://documents.ats.aq/recatt/Att605_e.pdf.

A Monitoring and Audit strategy has also been implemented in previous seasons, comprising the completion of a Project Variation Register (PVR), as well as two environmental audits being undertaken during a season, to ensure that early warning and reporting of unforeseen adverse effects can be identified quickly. As a result, modifications of activities can be made through to improve processes through lessons learnt, should they be necessary in close collaboration with the Environment Office.

2.3 Sustainability

The BAS Sustainability Strategy for the AIMP[11] has been developed to ensure that BAS infrastructure is designed, constructed, and operated in accordance with best international sustainability practice. The strategy objectives were amended in October 2020 following a review with members of the Sustainability Assurance Group (SAG). The SAG has signed off a series of targets, metrics, and commitments for BAS projects. The Programme Performance Assurance Group is responsible for monitoring Key Performance Indicators (KPI), maintaining the strategy through regular updates, and benchmarking progress to ensure the AIMP remains at the forefront of sustainable development.

A sub-group of the SAG undertake sustainability assurance reviews at several points across a project's work stages in order to give confidence that the projects are following an appropriate process that can deliver on the pre-agreed sustainability benefits.

Presented in Table 2-1, the tabular Sustainability Strategy outlines eight aims with associated objectives. Covering key sustainability themes, the strategy has been developed through consideration of international best practice as well as the sustainability ambitions and requirements of the AIMP.

The AIMP Sustainability Strategy has been developed so that project teams are able to demonstrate and evidence the sustainability credentials of the construction projects. Two additional sustainability performance schemes apply to construction projects which also require evidencing:

1. Larger construction projects must achieve an "Excellent" rating within BREEAM and BREEAM for Infrastructure sustainability certification schemes. This is a NERC requirement for these projects.
2. All projects must also commit to the UK BIM Framework's Government Soft Landings (GSL) as required by public sector clients.

Furthermore, the AIMP Sustainability Strategy has been developed in alignment with the United Nation's (UN) Sustainable Development Goals (SDGs) which are recognised as a transparent and global definition of sustainability.

Project specific Sustainability Management Plans (SMP) are developed for individual AIMP projects. A sub-committee of the SAG review targets and objectives set for each SMP and provide an assurance function by co-ordinating regular reporting meetings to monitor and analyse the sustainability performance of these projects.

BAS has committed to achieving net zero carbon emissions by 2040 in line with the UKRI Environmental Sustainability Strategy. To support this goal, the Rothera Decarbonisation Strategy[12] aims to have permanently zero greenhouse gas (GHG) emissions in its operational activity at Rothera by 2030. There are six objectives within the Rothera Decarbonisation Strategy:

- Maximise the energy efficiency of Rothera's buildings;
- Develop a site energy infrastructure;
- Develop a smart grid;
- Electrify Rothera's fleet (vehicles, boats);
- Achieve extensive carbon neutrality in construction activities; and
- Increase positive impact by influencing supply chain.

[11] British Antarctic Survey, 2024. AIMP Sustainability Strategy. Available at: Sustainability - British Antarctic Survey (bas.ac.uk)

The Rothera Decarbonisation Strategy identifies a set of milestones and enabling works that will need to be delivered in order to achieve zero operational GHG emissions by 2030.

Table 2-1 AIMP Sustainability Strategy Aims and Objectives

Aims designed using the UN Sustainable Development Goals		Objectives to manage Carbon, Climate Change adaptation, Materials, and Environmental Impacts
1	Create and maintain healthy working areas	• Review the BAS Health and Wellbeing Strategy and consider implications for construction and operation activities
2	Maintain an efficient and sustainable water and wastewater regime	• Ensure water conservation and recycling principles are incorporated into design proposals. • Review wastewater (treatment) regime and consider alternative, more sustainable solutions. • All operations will be planned to minimise water consumption
3	Create an efficient, reliable, and sustainable Antarctic energy network	• Minimise energy related carbon emissions through best practice design across all AIMP projects through reducing energy demand and using low-carbon sources of energy • Minimise energy-related carbon emissions during operational phase of AIMP projects through reducing energy demand
4	Ensure resilient facilities through sustainable and appropriately innovative design	• Encourage innovation throughout the design and procurement process • Challenge designs by targeting ambitious sustainability goals and ratings through following principles of BREEAM or equivalent as agreed by UKRI/NERC/BAS. • All work to adhere to BAS Resilience Strategy
5	Develop and maintain inclusive, safe, resilient, and sustainable BAS Antarctic communities	• Maximise liveability and community-centric building design e.g., thermal comfort, air quality and natural daylight through best use of design standards • Maintain and regularly monitor the performance of project infrastructure to ensure that it continues to meet the needs of the Antarctic community • Embed health and safety considerations within each project (aligning with the BAS H&S Policy)
6	Ensure responsible sourcing and efficient use of all resources through sustainable design and procurement	• Ensure sustainable sourcing of all materials and services throughout the supply chain, to be recorded within a Sustainable Procurement Statement for each project • Ensure sustainable use of materials and facilities through application of the Waste Hierarchy and the integration of circular economy principles
7	Prioritise action to combat climate change and its impacts	• Establish whole life GHG emissions reduction targets for all projects, including the application of PAS 2080 (Carbon Management in Infrastructure) • Design and deliver facilities that are resilient and adaptable to the impacts of climate change • Establish low-carbon leadership at Board level (Note this applies at programme level only and is not included in project specific SMPs)
8	Interact sustainably with the Antarctic environment	• Project designs shall demonstrate that construction and operation of facilities will have no lasting negative impact on life below water, life on land, or the natural environment • Projects should demonstrate ongoing monitoring of environmental impacts on sensitive receptors identified and agreed within the EIA • Uphold the highest standard of biosecurity for all personnel, cargo, plant, and materials that enter or re-enters the Antarctic environment through project-specific Biosecurity Plans and provision of training for all site operatives

3. DESCRIPTION OF THE PROPOSED ACTIVITIES

3.1 Purpose and Need

The AIMP has received significant investment to modernise and restore Rothera's infrastructure so that it remains at the forefront of climate, biodiversity, and ocean research, and is cost effective, safe and minimises demand for energy by improving energy efficiency. Many of the existing buildings have reached, or are near to, the end of their economic life, driving up maintenance costs and reducing organisational resilience. The general objective of the AIMP, therefore, is to reduce operating costs at Rothera whilst maintaining current operations in Antarctica through:

- Replacing aged buildings with modern, more flexible spaces to minimise future maintenance and operating costs and significantly improve the energy efficiency to support BAS Net Zero targets; and
- Consolidating and rationalising the existing estate to provide infrastructure which minimises energy use and reduces the costs of snow clearance and maintenance of services.

The vision for Rothera and the strategic aims of the AIMP are as follows[12]:

- To be a centre of excellence for polar science for all UK scientists;
- Outstanding operational delivery;
- Integrated logistical hub that allows access to the rest of the continent;
- Network-enabled station for multi-disciplinary science;
- Station of choice for international collaboration;
- Showcase for UK science and technology; and
- A test bed for cutting-edge innovation for extreme environments.

The strategic aims of the AIMP include:

- Enable and support frontier science;
- Implement the UKRI environmental sustainability strategy; and
- Champion public engagement.

The proposed activities included in this assessment will play a pivotal role in realising the vision for Rothera and meeting the strategic aims of the AIMP. The proposed scope of works is outlined in this Section.

3.2 Proposed Activities for 2024 – 2025 and 2025 – 2026 Seasons

Several of the proposed activities for the 2024 – 2025 and 2025 – 2026 Seasons have been deferred from a previous season and have therefore already been assessed and approved within previous PEAs and/or IEEs. Where the proposed methodologies for these activities remain unchanged as approved these are referred to as 'Previously Assessed Activities'.

In addition, there are also several proposed activities for the 2024 – 2025 and 2025 – 2026 Seasons which comprise elements that have been approved in previous PEAs and/or IEEs but have since been subject to alterations and/or additions to their original scope and have therefore been reassessed within this IEE – these are referred to as 'Previously Assessed Activities with Scope Changes'.

The previously assessed activities and those with scope changes are listed in

[12] BAS, 2024. Rothera Research Station Modernisation website. Accessed at: Rothera Research Station Modernisation - British Antarctic Survey (bas.ac.uk)

Table 3-1. It is worth noting that activities previously assessed within IEEs have been reviewed and approved by both BAS and FCDO, whereas activities that have been previously assessed within PEAs have been reviewed and approved by BAS but have not been reviewed by FCDO until now as part of inclusion within this IEE.

In addition to the EIA reporting, specialist activities in Antarctica are prohibited without the issue of a specialist activity permit under the Antarctic Act (1994; 2013), Sections 6 to 10 including:

- Mineral resource activities (Section 6);
- Disturbance/harmful interaction with fauna and damage to flora (Section 7);
- Introduction of non-native species (Section 8);
- Entry into protected areas (Section 9); and
- Damage or disturbance of Historic Sites and Monuments (Section 10).

These Specialist Activity Permits may be issued by the FCDO or by the BAS Director under delegated authority in accordance with the UK Antarctic Act (1994; 2013). It should be noted that Specialist Activity Permits reviewed by the FCDO are to permit a particular activity and are not necessarily viewed holistically in relation to other projects and day-to-day activities at Rothera.

Finally, there are proposed activities which are new to the 2024 – 2025 and 2025 – 2026 Seasons that have not been assessed in any previous EIA – these are referred to as ‘New Activities’.

Refer to

Table 3-1 and Section 3.3 for further detail regarding these activities, including whether they have been previously assessed (and if so in which document), or if they are new, how they will be assessed within this IEE.

Table 3-1 Proposed Activities for the 2024 - 2025 and 2025 - 2026 Seasons, Project, and Assessment in Brackets where applicable

Previously Assessed Activities	Previously Assessed Activities with Scope Changes	New Activities
Future Aircraft Capability: CBR Measurements (RUNSUR) (RUNSUR IEE 2022)	Cabling for Solar Monitoring West of Runway (RENEW) (RUNSUR IEE 2022)	VLF Equipment Relocation (VLF)
Future Aircraft Capability: Friction Testing (RUNSUR) (RUNSUR IEE 2022)	Solar Photovoltaic (PV) Building Condition Surveys (RENEW) (RUNSUR IEE 2022)	East Mooring Point SI Works (WHARF)
Non-Engineered Slipways (RUNSUR) (RUNSUR IEE 2022)	Connecting Admirals and Discovery Buildings to the STP Drainage Installation (RMP) (RMP IEE 2019)	Excavating, Replacing and Backfilling Frozen Ducts (RMP)
Hangar Site Investigation (SI) Works (HANGAR) (RUNSUR IEE 2022)	Strip Out of Existing Assets (RMP) (RMP IEE 2019)	Managing Defects from 2023-2024 Season (RUNSUR)
Mooring Weights (WHARF) (AIMP Combined PEA 2023-2024)	Deconstruction of Existing Assets (RMP) (RMP IEE 2019)	Defrosting and Waterproofing Frozen Chambers (RUNSUR)
RMP SWS Remedial Work (RMP SWS 23/24)	Removal and Containerisation of Waste, Removal of Containers from Rothera and Reprofiling of Ground (RMP) (RMP 2019)	BAM Fitters Workshop to IWHF SWS Re-Route (RMP)
Discovery Earthing and Vehicles Fuel Tank Installation 23-24 Season (RMP SWS Mar 24)	Removal of Processed Aggregate (RUNSUR) (AIMP Combined PEA 2023-2024)	Vikings House to Bentham Container Ducting (RMP)
Installation of Wind Deflector, Completing Sitewide Services, and Finishing Works of Discovery Building (RMP 2019)		Bonner Laboratory to Gerritsz Laboratory SWS Rerouting (RMP)
		Bentham Communications Container to ARIES Dome Power Cable (RMP)
		Excavation and Backfilling beneath Discovery North Yard Concrete Slab (RMP)
		Installing an external slab to the north yard of Discovery (RMP)
		Reprofiling road between Admirals to Runway Crossing (RMP)
		Temporary South Access Road to Discovery Building (RMP)
		Cleaning of Low Temperature Hot Water Pipework (SUPPORT)
		Sterilisation of Potable Water Systems (SUPPORT)
		Crane Winterisation (RMP)
		Survey Control Point Installations (SUPPORT)
		Processing Trench Dug Material (RUNSUR)

A plan showing the location of these activities is presented in Figure 3-1

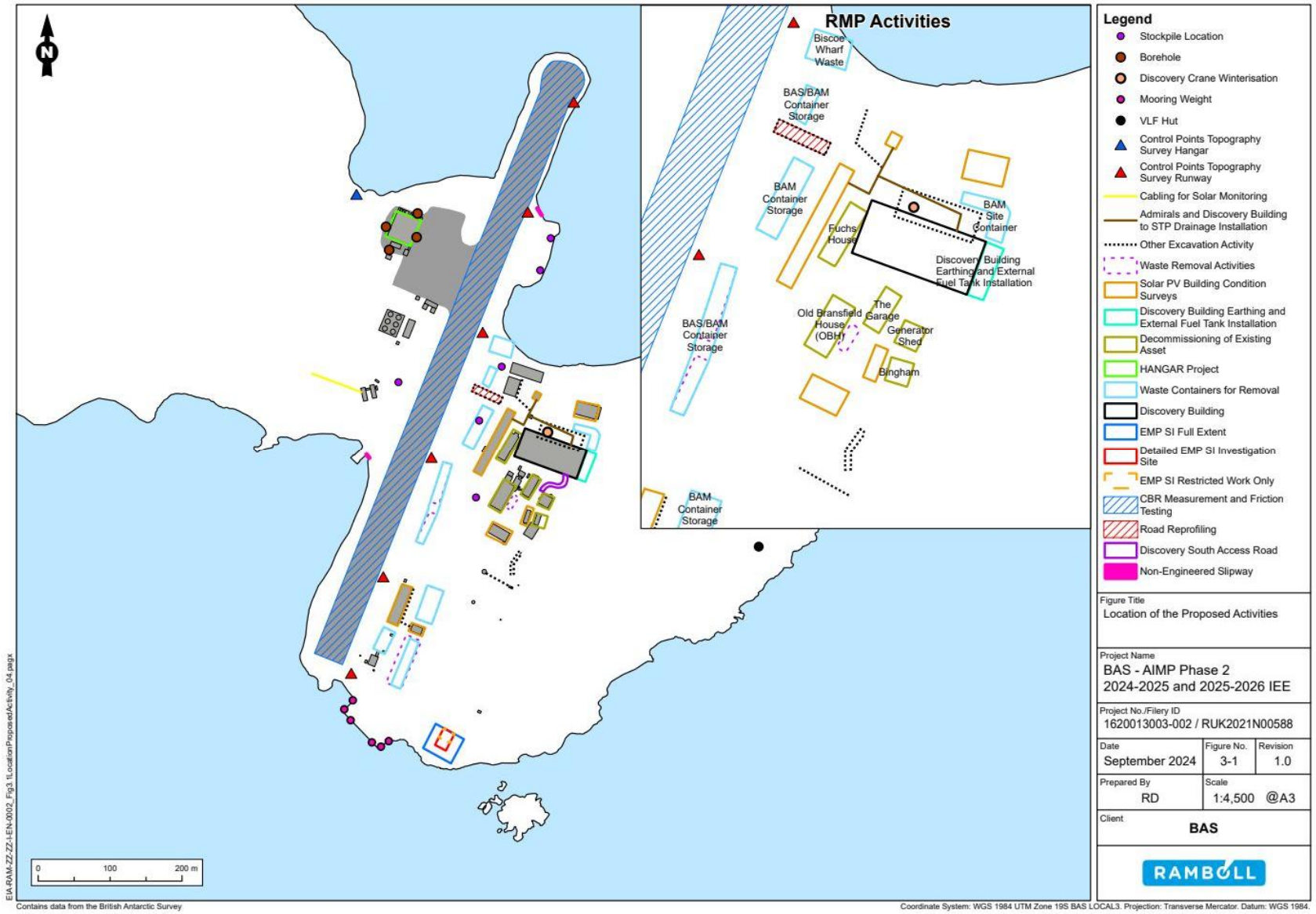

Figure 3-1 Location of the Proposed Activities for the 2024-2025 and 2025 - 2026 Seasons

3.3 Previously Assessed Activities

These are previously assessed activities that have been carried over from previous seasons and as a result have already been approved, namely within the RUNSUR IEE 2022 or the AIMP Combined PEA for the 2023 - 2024 Season[13], and are set out within this Section. The proposed methodologies for these activities are unchanged as previously approved. For the purposes of this IEE these activities have not been described further within Section 4, nor have their respective impacts been assessed in Section 11.4 to Section 11.21. However, the previously assessed activities may result in cumulative impacts with other activities taking place at Rothera, either included within this IEE or undertaken as day-to-day activities, which require consideration within this IEE. Therefore, the previously assessed activities are included within Section 12.

HANGAR

3.3.1 Hangar Ground Investigation Works

The GI works proposed for the upcoming 2024 – 2025 and 2025 – 2026 Seasons at the Hangar were included as part of the 'Ground Investigation (GI) for Foundation Design' activity, as set out and approved in the RUNSUR IEE. The GI is required to provide geotechnical information should the Hangar redevelopment design utilise rock anchors.

While some of the GI works at the Hangar were successfully undertaken during the 2023 – 2024 Season, including the two trial pits (TP) - TP04 and TP05, at the north-west and south-west corners of the Hangar. The four boreholes forming part of the proposed 'GI for Foundation Design' activity were eventually de-scoped and pushed back to the upcoming programme.

Accordingly, the proposed GI activity at the Hangar for this upcoming season comprises the remaining four boreholes. The methodology remains the same as originally described in the RUNSUR IEE 2022. Up to four rotary boreholes would be drilled approximately 20 m below ground level to retrieve soil/rock core samples which will then be exported to the UK for geotechnical testing (point lead and unconfined compressive strength) and chemical testing (pH value and sulphate). A Specialist Activity Permit would be submitted for the collection of samples of rock material and removal to the UK for testing. In-situ testing in boreholes is not required.

The work would require a C6 Casagrande drill, borehole casings, an excavator, core liner and core boxes, two C6 drill operatives, and one geotechnical engineer logger. No hydrocarbon based or bentonite drilling fluids would be used. Water or air would be used as a flush medium to progress the boreholes. The drilling contractor would take appropriate measures to obtain the best possible core run (total core recovery >90 %).

Boreholes will be logged and photographed in accordance with the recommendations of BS 5930: 2015 Code of Practice for Ground Investigations by a suitably experienced geotechnical engineer/engineering geologist. Cores would be securely packed in labelled core boxes at the drill rig. Boreholes will be surveyed and levelled, and the as-built location marked on a plan of the site.

[13] British Antarctic Survey, 2023. AIMP (2023-2024) Combined Preliminary Environmental Assessment (PEA)

Figure 3-2 shows the proposed borehole locations at the Hangar (note that the two trial pits included in this plan were completed during the 2023 - 2024 Season).

Figure 3-2 Proposed borehole locations for the Hangar SI

The programme and timing of these works are not known, although these works will require access to the ground surface and will be undertaken once snow is cleared, assumed from December onwards in one season (not both).

WHARF

3.3.2 Mooring Weights

The Mooring Weights activity, part of the Wharf Project, was first assessed in the AIMP Combined PEA for the 2023 - 2024 Season. The mooring weights are required as a means of securing small boats to the wharf during the process of deployment and retrieval to increase safety during this process.

The aim is to install six weighted mooring lines on the eastern, southern, and western faces of the Rothera Wharf (two weights at each site). The mooring weights were cast in the 2021 - 2022 Season and consist of a cut drum (approximately one foot high) filled with concrete. Four mooring weights left over from the Biscoe Wharf are in good condition and will be used as part of this project, to minimise the need for additional concreting. The weights will be permanently deployed and will sit on the seabed.

The activity was originally scheduled to be undertaken during the 2023 – 2024 Season but was subsequently postponed to the upcoming 2024 – 2025 Season.

RUNSUR

3.3.3 Future Aircraft Capability – CBR Measurements of Runway

The Future Aircraft Capability (FAC) California Bearing Ratio (CBR) Measurements activity, included as part of the RUNSUR Project, was first assessed in the RUNSUR IEE 2022 and approved in a subsequent AIMP Combined PEA for the 2023 - 2024 Season. The CBR measurements are required to ensure that the Rothera runway meets the FAC minimum requirement of 30.

The measurements have been undertaken as part of ongoing CBR measurements of the runway. CBR measurements will be a continued requirement as an ongoing monitoring activity to enable BAS to ensure the bearing strength of the runway remains consistent throughout the season and is not affected by the RUNSUR project activities, to be undertaken during the 2024 – 2025 and 2025 – 2026 Seasons, as well as future Seasons as a yearly activity as part of the BAS Air Unit activities.

The methodology has not changed as set out in the AIMP Combined PEA for the 2023 - 2024 Season, as approved by the BAS Environment Office.

3.3.4 Future Aircraft Capability – Friction Testing

The FAC Friction Testing activity, required as part of the RUNSUR Project, was first assessed in the RUNSUR IEE 2022 and approved in a subsequent AIMP Combined PEA for the 2023 - 2024 Season. The aim of this activity is to undertake friction measurements at strategic points along the runway to determine friction at various points of the season including early in the season, melting season, mid-season, and during the onset of winter, to assess the performance of the BAS future aircraft at various points throughout the season.

The measurements have been undertaken as part of ongoing friction measurements of the runway. Friction measurements will be a continued requirement as an ongoing monitoring activity to be undertaken during the 2024 – 2025 and 2025 – 2026 Seasons, as well as future Seasons as a yearly activity as part of the BAS Air Unit activities.

The methodology has not changed as set out in the AIMP Combined PEA for the 2023 - 2024 Season.

3.3.5 Non-Engineered Slipways

This activity was original assessed in the RUNSUR IEE 2022. However, the work was not undertaken due to a lack of available stockpile material and the activity was postponed to the upcoming 2024 – 2025 Season.

Two new non-engineered slipways are proposed at two locations north of the windsock and at the site of the former temporary jetty, which was removed in the 2022 - 2023 Season[14]. These locations are shown in Figure 3-1.

The availability of safe boat launch areas at Rothera have reduced over the years and the provision of the slipways will improve access and boat launching capability, which is required to enhance Search and Rescue (SAR) safety response.

The slipways will be 6.5 m wide and will extend to a depth of 1.5 m below the water line at a 20% gradient, in order to provide sufficient under keel clearance. The slipways will be made with an excavator on the beach using processed stone already available on site at Rothera. The required quantity (less than 100 tonnes) of 30-80 mm crushed rock for each slipway will be transported from the appropriate stockpile using a dump truck, deposited carefully at the location of the slipway, and spread into position using an excavator with sufficient reach to avoid having to go into the water.

3.4 Previously Assessed Activities with Scope Changes

The previously assessed activities with scope changes have been carried over from previous seasons and assessments (RMP IEE 2019; RUNSUR IEE 2022 and PEAs). Differences in how these activities were previously assessed, in terms of duration and methods, or changes in the level of information available to inform environmental assessment mean that these activities will be re-assessed as part of this IEE.

[14] British Antarctic Survey (BAS), 2023. AIMP Post-Season EIA Review – 2022 / 2023 Season

The differences in methodologies are explained in the relevant sections below and have been assessed in Section 11.21.

The scope of changed activities assessed within this IEE includes the following:

- Updated Cabling for Solar Monitoring West of Runway (RENEW) – previously assessed in RUNSUR IEE 2022;
- Altered Solar PV Building Condition Surveys (RENEW) – previously assessed in RUNSUR IEE 2022;
- Altered Connecting Admirals and Discovery Buildings to the Sewage Treatment Plant (STP) Drainage Installation (RMP) – previously assessed in the RMP IEE 2019;
- Discovery Earthing and External Fuel Tank Installation (RMP) – previously assessed in the Rothera Modernisation Phase 1 – RMP / Sitewide Services March 2024 PEA15
- Delayed Strip Out of Existing Assets (RMP) - previously assessed in the RMP IEE 2019;
- Altered Deconstruction of Existing Assets (RMP) – previously assessed in the RMP IEE 2019;
- Altered Removal and Containerisation of Waste, Removal of Containers from Rothera; Reprofiling of Ground (RMP) – previously assessed in the RMP IEE 2019;
- Altered Defrosting and Replacement of Flooded / Frozen Ducting (RUNSUR) – previously assessed in the AIMP Combined PEA for the 2023 - 2024 Season; and
- Altered Removal of Processed Aggregate (RUNSUR) – previously assessed in the AIMP Combined PEA for the 2023 - 2024 Season.

3.4.1 Renewable Energy (RENEW)

The proposed RENEW activities for the 2024 - 2025 and 2025 - 2026 Seasons comprise enabling works for the monitoring of solar resources to inform future decision-making around renewable energy infrastructure. The proposed activities align with the aims and objectives of the AIMP Sustainability Strategy as well as the Rothera Decarbonisation Strategy.

The proposed monitoring enabling works and condition surveys required to support the renewable energy project are outlined below. The detailed methodologies for RENEW are included in Section 4.1.

Cabling for Solar Monitoring West of Runway

Solar irradiance and albedo monitoring will be undertaken at a single location to determine the efficacy of solar energy generation. The monitoring aims to establish the level of solar irradiance and albedo effects from one of the proposed locations for ground mounted solar PV. The data collected by the solar monitor will inform future development of ground mounted solar PVs behind the fuel farm.

The activity is an update on work previously approved under the RUNSUR IEE 2022, with the North Beach monitor having been set up during the 2023 – 2024 Season. However, there have since been network connectivity issues with the location of the monitor adjacent to the fuel farm.

As a result, the solar monitor had to be moved to a new temporary location immediately west of the meteorological balloon container, see Figure 3-1.

However, this arrangement does not allow for consistent data to be logged.

In the upcoming 2024-2025 Season, a more appropriate solution will need to be implemented to allow for consistent data logging. At this stage in the project the future location of the ground mounted solar panels is not known. If a better location can be identified within the season that is more reflective of the future location of the ground mounted solar panels, then it is proposed that the solar monitor will be moved to this location. In this case, trenching for a single buried power and data cable between the South Cove Feeder Pillar and the new location of the solar monitor may be required. The dimensions of the proposed trench will be no more than 20 m length x 1 m width x 1.2 m depth.

[15] British Antarctic Survey (BAS), 2024. Rothera Modernisation Phase 1 – RMP / Sitewide Services March 2024 Preliminary Environmental Assessment (PEA).

The detailed methodology is included in Section 4.1.1.

Solar PV Building Condition Surveys

The activity aims to establish the structural integrity of the buildings at Rothera that have been identified to support Building Integrated Solar PVs (BIPV) in the future, thus aiming to lower the carbon footprint at Rothera.

The activity is an update on work previously approved under the RUNSUR IEE 2022. Some visual condition surveys were undertaken during the 2023 – 2024 Season, including at NBH, Gerritsz Laboratory and Giants House buildings. The survey methodology will remain the same as set out and approved in the RUNSUR IEE 2022. However, for this upcoming 2024-2025 Season additional buildings will be surveyed including Bonner Laboratory, Admirals House, and the Sewage Treatment Plant (STP).

The detailed methodology is included in Section 4.1.2.

3.4.2 Rothera Modernisation Project (RMP)

The proposed altered RMP works covered in this section comprise a variety of activities including minor excavation works and placing of concrete slabs external to the building, the removal of waste containers, reprofiling of the ground, the strip-out and deconstruction of several decommissioned buildings, and the creation of a temporary access road to the Discovery Building to maintain access to the building while works in the north yard are ongoing. These activities are considered to be required to facilitate the RMP objectives.

The below RMP activities were all originally included in the RMP IEE 2019 but have been subject to alterations and/or additions to their scopes.

Drainage Installation between Admirals and Discovery Buildings to the STP

This activity is required to establish new drainage routes connecting the Admirals and Discovery buildings directly to the STP. It was originally listed in the RMP IEE 2019 but could not be undertaken due to a lack of available resource during the 2023 – 2024 Season. While the original methodologies as set out in the RMP IEE 2019 remain the same, the current scope includes some additional drainage connections from the STP to the Discovery Building and is therefore included for reassessment in this IEE.

The detailed methodology is included in Section 4.4.2.

Discovery Earthing, Service Ducts and External Fuel Tank Installation

This activity forms part of the Discovery Building's external slab and earthing arrangement at its north-eastern side. The proposed activity is required to deliver the agreed final design and BAS capability delivery of the Discovery Building.

The activity was previously set out in a RMP Phase 1 PEA 2024 however it will be included for reassessment in this IEE.

The detailed methodology is included in Section 4.4.2.

Strip Out of Existing Assets

As part of the commencement of decommissioning RMP buildings, this activity involves the soft strip-out the following six workshops:

- Carpenter's Shed;
- Bingham's;
- Fuchs;

- Generator Shed;
- The Garage; and
- Old Bransfield House (OBH).

The strip out, decommissioning and deconstruction of existing BAS assets was originally included and approved in the RMP IEE 2019, and this activity was anticipated to take place between January – April 2023. However, the impact of COVID, programme alterations and resource constraints throughout construction seasons at Rothera since 2019 have led to delays which have prevented work being conducted as intended. Programme revisions have subsequently taken place to undertake this activity within the austral winter 2025, however due to further delays during the 2023 – 2024 Season, this activity has now been pushed back to the austral summer of the 2025 – 2026 Season. Due to the extensive delays in commencement and additional information on the decommissioning process becoming available, this work will be re-assessed in this IEE.

The detailed methodology is included in Section 4.4.8.

Deconstruction of Existing Assets

Following the strip-out of the six assets listed above over austral summer 2025 - 2026, the deconstruction of these assets would take place. This activity comprises the clearance, deconstruction and removal of legacy buildings and is anticipated to last throughout the 2025 - 2026 Season.

As with the strip-out works, this item was initially assessed within the RMP IEE 2019, however it has been decided to remove all foundations and reprofile the ground, which represents a scope and methodology change from the activity previously assessed, therefore requiring this activity for inclusion in the assessments within this IEE.

The detailed methodology is included in Section 4.4.9.

Removal and Containerisation of Waste, Removal of Containers from Rothera and Ground Reprofiling

The containerisation of the removed Biscoe Wharf (replaced by the Wharf Project) and RMP waste was originally referenced in the RMP Project Execution Plan (2016): the waste will be stored at Rothera in the interim before shipping to the UK. For the first season (2019 - 2020) the waste was collected for the Biscoe Wharf and RMP together. Since this initial activity, all waste has been segregated and stored in 20 ft or 40 ft containers. These containers are stored between Admirals and the runway. This container storage activity was also set out in Section 4.2 of the RMP IEE 2019.

The additional scope for the 2024 - 2025 and 2025 – 2026 Seasons comprises the shipment of this waste material back to the UK on a commercial vessel, as well as the subsequent reprofiling of the ground beneath the locations of the waste containers. Thus, this activity will be assessed within this IEE.

The detailed methodology is included in Section 4.4.10.

3.4.3 Runway Resurfacing and Lighting Activities

Defrosting and Replacement of Flooded / Frozen Ducting

The proposed activity comprises some non-intrusive works in the form of jetting water through ducting to defrost them, with some intrusive maintenance works to waterproof the chambers that previously flooded. More intrusive works to replace the frozen chambers may be required which has been detailed under ‘scenario B’ in Section 4.3.2. This activity aims to ensure that the Airfield Ground Lighting (AGL) chambers and ducting are in good condition and continue working effectively.

New ducting installed during the 2022 - 2023 Season on the west of the runway to the south of the Hangar and between below-ground chambers on the eastern side of the runway and the AGL kiosk, were found to be flooded and frozen during the 2023 - 2024 Season. This activity is needed to defrost and, if needed, replace the affected below-ground services.

The activity was previously assessed in the AIMP Combined PEA for the 2023 - 2024 Season. However, the work was not undertaken due to other RUNSUR activities at this location taking resource and programme priority, and the activity was postponed to the upcoming 2024 – 2025 Season. The methodology has changed since set out in the PEA and will now comprise defrosting using water jetting equipment, or excavation of the ducts; therefore, the activity requires reassessment within this IEE.

The detailed methodology is included in Section 4.3.2.

Removal of Processed Aggregate

This activity comprises moving processed aggregate from the area south of the Hangar, as well as subsequent excavation work to reprofile and level the ground in this area. The material for use on the runway will be moved to the processing area near the wharf. After screening and reprocessing, it will be stockpiled to the west of the runway with the rest of the processed material.

The material was processed from rock blasted at the wharf area and was laid during the 2019-2020 Season. The material is graded 0-80 mm, and the top layer is graded 0-30 mm (Section 6 Permit Refs: 12/2019-20 and 07/2018).

The activity was previously assessed in the AIMP Combined PEA for the 2023-2024 Season. However, the work was not undertaken due to other RUNSUR activities at this location taking resource and programme priority, and the activity was postponed to the upcoming 2024–2025 Season. The methodology has changed since set out in the PEA and therefore the activity requires reassessment within this IEE.

The detailed methodology is included in Section 4.3.5.

The proposed activities outlined in Section 3.4 are scheduled to be completed over the 2024–2025 and 2025–2026 austral summer Seasons and one austral winter during 2025, with the first commencing in November 2024 and ending April 2025 and the second commencing November 2025 and ending April 2026. Section 8 outlines when the proposed activities are taking place across the 2024–2025 and 2025–2026 Seasons.

3.5 New Activities

The new activities proposed for the 2024-2025 and 2025-2026 Seasons have been divided into four key projects, as highlighted in Section 3, these include: WHARF, RMP, RUNSUR and VLF Equipment Relocation.

New scope activities included within all stages of assessment for this IEE are as follows:

- East Mooring Point SI Works (WHARF);
- Excavating, Replacing and Backfilling Frozen Ducts (RMP);
- Other RMP Excavation Activities (all RMP):
  - BAM Workshop to Interim Waste Handling Facility (IWHF) SWS Re-Route (RMP);
  - Vikings House to Bentham Container Ducting;
  - Bonner Laboratory to Gerritsz Laboratory SWS Rerouting;
  - Communication Tower to ARIES Dome Power Cable;
  - Excavation and Backfilling beneath Discovery North Yard Concrete Slab; and
  - Reprofiling Road between Admirals to Runway Crossing
  - Temporary South Access Road to Discovery Building.
- Managing Defects from 2023 - 2024 Season (RUNSUR);

- Waterproofing Flooded Chambers (RUNSUR);
- Processing Trench-Dug Material (RUNSUR); and
- VLF Equipment Relocation.

3.5.1 WHARF

3.5.2 East Mooring Point SI Works

The proposed wharf activities comprise site investigations to establish the feasibility of a new East Mooring Point to stabilise the SDA whilst it is moored at the wharf. The existing mooring point rock is located off the coast of Cheshire Island and not considered an optimal solution, it poses a safety issue as the low height of the line is at risk of iceberg collision, resulting in a 24-hour watch to alert the SDA boat team should such an event occur. A potential new East Mooring Point would provide a new land-based anchor to secure the SDA, aiming to increase safety and reduce the operational burden of the SDA boat team.

As part of the wharf activities for the upcoming season, SI works will be carried out at the proposed site in order to understand the geophysical properties of the potential new mooring point area, and the ice shelf to the south. If the project is progressed beyond the SI works assessed in this IEE, the full project will be captured in a subsequent EIA that considers all alternatives and the do-nothing approach in full.

The detailed methodology is included in Section 4.2.1.

3.5.3 Rothera Modernisation Project

The proposed new RMP activities covered in this section comprise various minor construction activities and maintenance activities required to facilitate the RMP project.

Remedial works to amend frozen ducts

Several ducts forming part of the newly installed SWS, were recorded frozen during the 2022 - 2023 and the 2023 - 2024 Seasons. Planned works at the affected below-ground services will firstly comprise defrosting and, if needed, replacement. The proposed work would occur at:

- Hangar to Runway, 5 no. 150 mm ducts (170 m in length); and
- Runway to Fitters Workshop, 5 no. 150 mm ducts (50 m in length).

The detailed methodology is presented in Section 4.4.1.

Other Excavation Activities

There are several minor RMP construction activities proposed for the 2024–2025 and 2025–2026 Seasons. These largely comprise additional SWS installations, the repositioning / realignment of SWS infrastructure, connecting buildings to new power sources, minor groundworks associated with earthing and installing service ducts for the Discovery Building and the creation of a temporary access road to the Discovery Building.

The detailed RMP methodologies are included in Section 4.4.2.

3.5.4 Runway Resurfacing and Lighting – Snagging Activities

Previous RUNSUR activities which were undertaken during the 2022 – 2023 and 2023 – 2024 Seasons, assessed within the RUNSUR IEE 2022, were required to improve the condition of the runway.

The previous RUNSUR activities included the complete resurfacing of the existing runway and the provision of an extension to the gravel surface between 0 m to -17 m chainage at the southern end of the runway and 1 m at the northern end. A turning circle was added for aircraft to the east side at the southern end of the runway.

To facilitate future services, further RUNSUR activities have been proposed at the runway for the 2024 – 2025 and 2025 – 2026 Seasons. Maintenance of the runway surface is required to maintain effective Air Unit operations at Rothera. Additionally, several service ducts crossing the runway, installed during the 2022 - 2023 Season will require waterproofing, defrosting and, if potentially, replacing.

Thus, the proposed RUNSUR activities covered in this IEE comprise minor construction activities, such as maintenance, scarification and moving material. Following completion of works in this IEE, the maintenance of the runway will fall under BAS business as usual operations.

Managing Defects from 2023 - 2024 Season

As the runway surface is new and will compact with further use, the surface needs to be monitored for degradation as the new material settles, this could appear in the form of subsidence, rutting, potholes, or waves on the surface. If required, maintenance works will be undertaken to correct these defects.

The detailed methodology is presented in Section 4.3.1.

Waterproofing Flooded Chambers

New efficient AGL was installed at the Rothera runway during the 2022 - 2023 Season, consisting of Runway Entrance Lights (REL), Runway End Identifier Lighting (REIL), and (Abbreviated) Precision Approach Path Indicators ((A)PAPI). Associated trenches connecting the power and control cables between the lights and the AGL control kiosk run along the side of the runway and around the fuel farm.

Below-ground services, such as ducting and concrete chambers for the AGL were also installed. However, during inspection in the 2023 - 2024 Season, several of these chambers and ducts were found to be flooded. These below-ground services, therefore, require maintenance works to re-seal them and prevent future flooding.

The detailed methodology is presented in Section 4.3.3.

Processing Trench-Dug Material

This activity comprises crushing, processing, and moving material excavated during trenching. Any material considered unsuitable for backfilling runway trenches during the 2023 - 2024 Season was stockpiled on the western side of the runway. This stockpiled material will be crushed and screened if it is suitably sized, along with any additional suitable material from the frozen ducting repairs, see above, and processed for future runway maintenance (see ‘Managing Defects from 2023 - 2024 Season’ in Section 4.3.1) and stockpiled to the south of the meteorological balloon launching facility.

The detailed methodology is presented in Section 4.3.6.

3.5.5 Very Low Frequency Equipment Relocation

The VLF equipment is currently used for scientific purposes to monitor and measure weather in space. To enable the continued use of the VLF equipment for this purpose it needs to be relocated from its current temporary position within a spare room at OBH, which will be decommissioned in March 2025. A new self-contained facility (VLF Hut) located at approximately 67°34’11” S 68°07’01” W is proposed, which is further east, away from existing buildings.

The proposed new location at East Beach is approximately 60 m south-west of the existing Air Chemistry East Beach Hut (EBH). This location was chosen to prevent electromagnetic interference (EMI) caused by the presence of infrastructure associated with the new Discovery Building. The antenna is not being moved as part of this activity. The hut will be completely matte black in colour including the roof, and the access door will be self-finished brushed stainless steel. The VLF Hut will draw power from the Air

Chemistry Hut via an LV cable. As there is no spare electrical capacity at the Air Chemistry Hut, the existing cable routes from the Discovery Building to EBH would need to be upgraded to also provide power to the new VLF Hut, Figure 3-3.

The detailed methodology is included in Section 4.5.

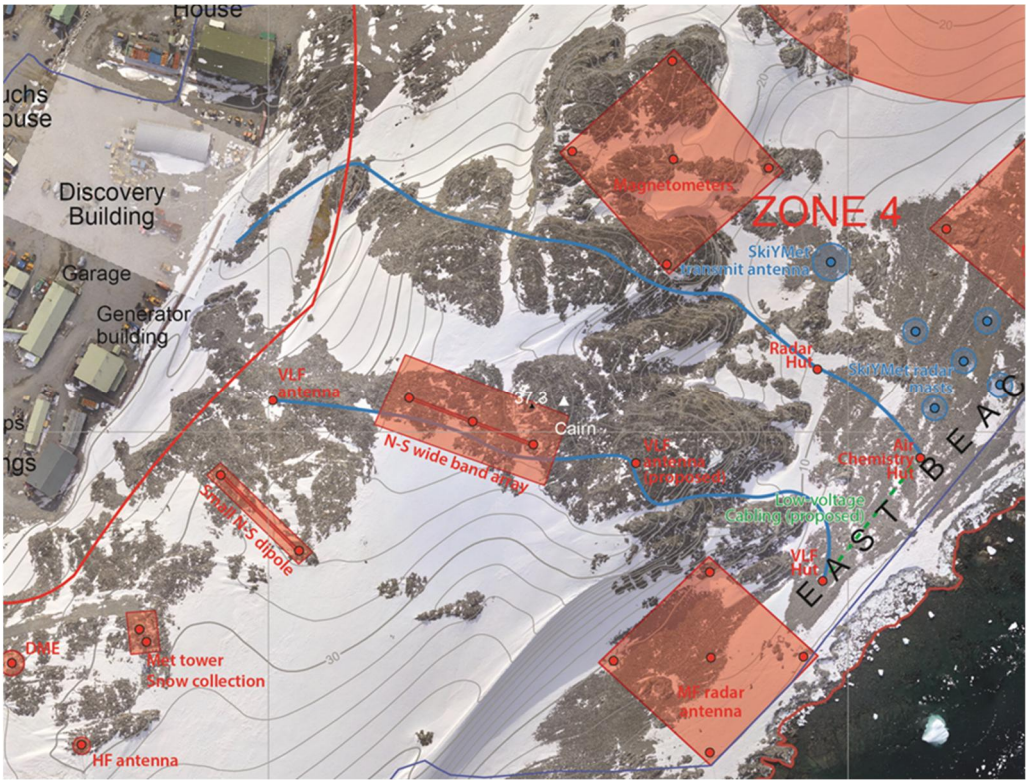

Figure 3-3 Proposed VLF Hut Location. New cabling route shown in green, with existing cables to be rerouted shown in blue.

3.6 Operational Activities

The activities outlined in this IEE will not result in a further change in operational behaviour and activity at Rothera, outside of those associated with having the station at capacity, and the potential for additional personnel rotations. Therefore, no operational impacts have been considered as part of the assessment of environmental impacts associated with the proposed activities within this IEE.

BAS Estates Activities and scientific activities will be taking place at Rothera during the 2024-2025 and 2025-2026 Seasons, which are considered business as usual activities required to facilitate BAS' presence and activities.

3.7 Anticipated Waste

Both the RUNSUR SWMP (2023)[16] and the Rothera Modernisation Project SWMP (2023)[17], Appendix 1, identify and monitor types and quantities of waste generated by the proposed works, waste minimisation methods to be implemented, and storage and disposal options for each waste stream. These plans are considered to remain up to date. Additional waste produced from the RUNSUR and RMP activities assessed within this IEE will be logged by an environmental engineer who will be on site within season to track both the amount and type of waste produced on site on a monthly basis. This information, along with total waste produced annually, will be fed back to BAS, and logged in the associated Post-Season Environmental Report (PSER).

[16] BAM Nuttall, 2023. Management Template MT19: Runway Resurfacing and Lighting Project Execution Plan – Schedule C5 Site Waste Management Plan
[17] BAM Nuttall, 2023. Management Template MT19: Rothera Modernisation Project Execution Plan – Schedule C5 Site Waste Management Plan

The SWMPs also define selected waste management measures of prevention, reuse, recycling, and recovery and quantification at the end of the project. This allows a comparison to be made between forecast and actual waste quantities. Generation of waste material will be minimised at every stage of the project (design, procurement, construction, and deconstruction), and reduction strategies will be implemented as detailed in the SWMPs. All materials whether they are imported, reused 'as is' on site, recycled (on or off site) or sent off site for disposal are identified within the plan.

All waste generated from the Discovery Building and RUNSUR works is segregated and stored in closed ISO containers. Liquid waste, oil contaminated waste and chemical waste (such as chemical fixings cartridges) is stored in sealed 205 litre oil drums within the ISO containers. This follows the guidelines set out in the BAS Waste Management Handbook. These containers are routinely inspected to ensure appropriate storage practices are being followed by the BAM Environmental Engineer on site, as part of the EC01 environmental checklist and at least once a season as part of the BAS Environmental Management Audit schedule which meets ISO14001 requirements.

Table 3-2 below details the main waste expected to be generated from the deconstruction of the legacy RMP buildings during the 2024 – 2025 and 2025 – 2026 Seasons.

Table 3-2 Predicted Deconstruction Waste from RMP Legacy Buildings

	Concrete	Wood	Steel	Insulation	Plaster Board	Calcium Silicate Board	Cement Particle Board	Aqua Elite Board	Acoustic Insulation
	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)	(m^3)
Fuchs House	44.08	70.47	0.10	173.81					
Old Bransfield House	95.11	347.83	3.60	656.78		5.62		22.66	2.27
Ops Tower	20.00	18.11	2.57	25.83	9.12	0.10			
Generator Shed	75.38	22.06	2.00	47.43			7.538		
Tractor Garage	107.28	22.84	5.60	28.02	3.79				
Miracle Span	84.86		0.80						
Chippy Shed / Binghams	2.29	20.28		39.55					
Totals	**429**	**501.59**	**14.67**	**971.42**	**19.18**	**6.44**	**8.76**	**22.66**	**2.27**

It is also anticipated that the site will produce between approximately 20 to 30 containers filled with waste from the Discovery Building construction activities, undertaken across previous Seasons. In addition, there will be between approximately 60 to 70 containers of waste from deconstruction works and wharf steel.

Waste volumes will also include legacy steel waste from the past Biscoe Wharf deconstruction activity, which is currently stored at North Cove Beach.

Waste from the RMP deconstruction, Discovery construction and previous Biscoe Wharf activities would be removed from Rothera via commercial ship in March 2026, and transported back to the UK for processing and recycling or disposal at a licensed waste management facility.

BAM will manage all construction waste. Domestic waste from construction workers will be incorporated into the standard BAS waste management system. Overall, BAM aim to divert 80% of construction waste from landfill and 90% of all waste from landfill. Targets for specific projects may vary depending on the nature of the work, for example the waste diversion target for the RUNSUR activity is 98%.

3.8 Personnel

Rothera operates throughout the year. During the austral winter months, from April to mid-October, an approximate 25-strong team continues the science work and maintains Rothera's infrastructure.

A Resource Profile (Figure 3-4) for construction staff for the upcoming 2024-2025 Season, illustrates the construction personnel limit for the site (orange line), and the cumulative total of AIMP construction personnel anticipated to be based at Rothera (blue line) for the 2024–2025 Season:

- 2nd November 2024 – 8 (total number of construction personnel);
- 9th November – 16;
- 16th November – 24;
- 23rd November – 50;
- 15th February – 60 (capacity); and
- 19th April 2025 – 30.

Figure 3-4 Number of construction personnel at Rothera during the 2024 – 2025 Season

It is understood that a maximum capacity cap of 60 construction personnel is in place for the proposed 2024–2025 Season construction activities. The total number of people (including construction) at Rothera during the 2024-2025 Season, would peak at 174 in mid-January 2025 and would gradually reduce during late January and through February 2025, with Rothera operating at 140 people by March 2025. The impact of the ongoing and continuous presence of operational and science personnel at Rothera, on the environment, are considered to fall outside the scope of this IEE. However, consideration has been given for any potential effects on personnel at the Station, as a result of the proposed scope of activities during the 2024–2025 and 2025–2026 Seasons, which would prevent the continued scientific research and operations.

The construction staff members would comprise plant fitters, snow clearers, interior specialists (partitioners, fire stoppers, ceiling specialists, decorators, and flooring specialists), mechanical and electrical (M&E) specialists, and external specialists (SWS civil engineers, booth door specialists, heavy equipment operators, and various others).

At this stage, a Resource Profile for the subsequent 2025-2026 Season is unavailable. Therefore, this would instead be presented in full within the 2024-2025 Season PSER.

It is anticipated that a ‘transition’ team of approximately 43 people would be present throughout the 2025 austral winter (May to November), with a focus on the hand-over of the Discovery Building to BAS Operations. Only two members of this team will be AIMP contractors, the rest will be BAS personnel.

4. METHODOLOGIES

Where proposed activities result in ground disturbance these have been grouped into categories of terminology, and are shown in Table 4-1. Further activity and purpose text is presented to align with the methodologies within this section, to aid conversations around Section 6 Permitting.

Table 4-1 Ground Disturbance Categories and Activities

Category	Activity	Purpose
Backfilling and Infilling	Excavating and backfilling material	• Laying, removing, or replacing infrastructure below ground (drainage, cabling etc.); and • To remove or replace below ground infrastructure (foundations, pipes etc).
	Excavating material to reprofile ground	• Placement and compaction of fill to level ground; and • Reprofiling of ground levels post-deconstruction.
Maintenance	Excavating, replacing, and processing rock/ construction material	• Spreading processed material on roads and paths; • Other general maintenance tasks not related to a specific project; and • Rectify issues from degradation or damage.
Blasting and Excavation	Blasting and excavating, reprofiling ground and using fill elsewhere on site	• Removal of rock to a state that can be crushed/processed for use in construction; and • Levelling ground in preparation for construction
Excavation	Excavating, reprofiling ground and using fill elsewhere on site	• To process into aggregate/fill; and • Levelling ground in preparation for construction.
Placement of Fill	Placement of fill derived from previous activities	• Laying new infrastructure (foundations etc.); and • Levelling ground in preparation for construction.
Compaction	Disturbing the surface	• Scarification: mechanically breaking up the ground's surface to a shallow depth in order to prepare and resurface surfaces.
	Manually or mechanically compacting existing ground or placed fill	• Strengthen foundations and existing ground; and • Provide increase strength in laid material and improve mechanical interlock.
Site Investigations	Disturbing the surface	• CBR Testing/Plate Bearing test: establishing the ability/strength of the ground to support loads.
	Excavating and backfilling	• Trial Pits: typically, less intrusive than boreholes; assessing the ground conditions to understand the composition and suitability for construction works; and • Boreholes: typically, more intrusive than trial pits; assessing the composition, structure, and properties of the subsurface.
	Sample collections and testing on site	• In-Situ testing: establishing the composition of the sample and its ability to support construction activities.
	Sample collections and testing off site	• Off-site testing: taking samples back to the UK for analysis to establish the composition of the sample and its ability to support construction activities.
Crushing and Processing	Crushing blasted larger rock to a nominal size to be processed	• To reduce larger rock sizes to allow for future processing.
	Processing already excavated/blasted/crushed material	• To process into aggregate/fill.
Moving Material	Moving material from one location to another	• To facilitate construction by moving material out of the way; • To improve construction efficiency on site; and • Stockpiling aggregate for future construction projects.

4.1 Renewable Energy (RENEW)

4.1.1 Cabling for Solar Monitoring West of Runway (December 2024: One Week Duration)

The cabling activity to enable future RENEW solar monitoring will comprise excavating and backfilling material, to be undertaken by two members of the BAS Estates Team on behalf of AIMP over approximately one week in December 2024.

Depending on the agreed location of the solar monitor and its source of power, the solution proposed may require the trenching of a single new buried power and data cable between the South Cove Feeder Pillar and the monitor's new location:

1. If the monitor is to source power from the South Cove Feeder Pillar and be located north of the access road, the cable will need to be trenched below ground to prevent a tripping hazard, as well as damage from vehicles driving over it.
2. If the monitor is to source power from the South Cove Feeder Pillar and be located south of the access road, no trenching will be required.
3. If the monitor is to source power from the Fuel Farm power supply and be located north of the access road, no trenching will be required.

BAS Estates staff (two) will dig the cable route trench, measuring no more than 20 m length x 1 m width x 1.2 m depth, using an excavator. Approximately 24 m^3 of rock will be dug for the trench and will be backfilled after laying the cable.

4.1.2 Solar PV Building Condition Surveys (December 2024: One Week Duration)

This proposed activity will comprise non-intrusive visual condition surveys of roof structures at Bonner Laboratory, Admirals House and the STP to establish the structural integrity of the buildings and provide an initial view of suitability for future PV installation / solar thermal units. This activity follows on from similar visual condition surveys undertaken at NBH, Gerritsz Laboratory and Giants House during the 2023 – 2024 Season.

The activity will be undertaken by the Estates Team on behalf of AIMP, requiring one inspection engineer and one Mobile Elevation Working Platform (MEWP) operator.

4.2 WHARF

4.2.1 East Mooring Point SI Works (two days duration, between the 2024-2025 and 2025-2026 Seasons)

The activity would be undertaken by two BAM contractors over a duration of two days. It is assumed this activity will take place towards the end of the 2025/26 season, but this is dependent on site resource becoming available.

The SI team will access the site of the proposed mooring point pullout test (note that the pullout tests are not proposed to be undertaken during the 2024–2025 and 2025–2026 Seasons), accompanied by a BAS field guide, carrying ground penetrating radar (GPR) equipment and ice picks and shovels. The activity will not comprise heavy machinery or plant.

The team will use the GPR and hand tools to assess the extent of the rock conditions beneath the snow and ice at the demarcated area, Figure 3-1. The snow and ice would be hand-dug out in this area to expose and assess the extent of the underlying rock. No rock material will be excavated, collected or removed.

4.3 Runway Resurfacing and Lighting (RUNSUR) – Snagging Activities

The RUNSUR activities require excavation and stockpile movements for the activities included within this section. For all activities that require stockpiled material, the volume of stockpile material to be used will be set out in a Stockpile Management Plan, and the amount of material taken from the stockpile will be recorded at the time, see Section 5.5.

4.3.1 Managing Defects from 2023 - 2024 Season (end of January 2025 – March 2025)

This proposed activity would comprise maintenance of the runway to rectify issues from degradation and damage, should they arise. If required, the runway surface will be scarified by mechanically breaking up the surface to a shallow depth in order to prepare for resurfacing and compaction. At the time of writing, the extent of defects on the runway is unknown, exact locations and quantities will not be known until the 2024 – 2025 Season commences on site. The below methodology reflects the likely course of action to correct any defects.

Any repairs of the runway surface would cover the extent of the defect plus a 1 m allowance either side to allow a roller to adequately compact the area.

The new runway surface layer will be scarified to a depth of 100 mm to 350 mm, with the average depth being 200 mm to create a suitable surface for the new material to bind to. The total volume of runway surface to be scarified will not exceed 12,000 m^3.

The scarified material would remain in situ on the runway, with the intention being to re-use all of it to establish a new runway surface course. The scarified runway material, therefore, will not be stockpiled or reused elsewhere on site.

Any additional material required for the runway re-surfacing would be transferred from the stockpile on the western side of the runway (Stockpile 4), containing excavated material relating to the previous 2023 - 2024 Season and the RUNSUR trench excavations for the upcoming 2024 – 2025 and 2025 - 2026 Seasons, which is considered unsuitable to use as backfill. This material is due to be crushed and processed as part of the 2024 – 2025 Season RUNSUR activities, with a cone crusher and screener already on site.

For all activities that require stockpiled material, the volume of stockpile material to be used will be set out in a Stockpile Management Plan, and the amount of material taken from the stockpile will be recorded at the time, see Section 5.5.

4.3.2 Defrosting and Replacing Frozen Ducting (December 2024)

Maintenance work is also proposed for frozen below-ground runway infrastructure along the eastern and western sides of the runway. These methodologies are presented as two scenarios presented below. Scenario A sets out the defrosting measures, dependent on the success of this activity, Scenario B may be required to facilitate the replacement of damaged ducting.

Placement of fill obtained from previous activities (notably from the Wharf Construction, assessed within the Wharf CEE) may be required, as well as relocating unsuitable fill to a stockpile west of the runway (Stockpile 4) for processing and re-use for the runway re-surfacing. Fill will be deemed unsuitable if it is too large to be backfilled or too large for the cone crusher, which includes material over 300 mm in diameter. If excavated rock is too large for the cone crusher, it will be retained until specialist crushing equipment is available on site.

<u>Scenario A</u>

Specialist jet equipment that is typically used for cable duct desilting will be used to defrost the frozen ducting situated between chambers on the eastern side of the runway. This equipment is capable of pumping approximately 500 litres of seawater per hour. A successful jet water trial was conducted in Summer 2024 to understand how effective the process could be in defrosting the ducting. Water heating equipment will be available and could be used if cold seawater is not effective.

The jet water methodology comprises a pulsing water jet created system[18]. The pulsations flex a special lightweight hose helping it to travel hundreds of meters into the duct, clearing silt – or defrosting ice - as it goes, working at pressures which do not risk cable damage, and clearing lengths with a small amount of water. The process will utilise a 500-litre tank of seawater that can pump 500 litres of seawater per hour. Seawater will be recycled back into the tank to prevent the constant need to pump water. Seawater will be used instead of freshwater, as the reverse osmosis plant cannot provide enough freshwater.

Approximately 270 m of ducting would be cleared and inspected during this process. Ducts will be inspected through pressure testing and with the use of CCTV cameras. Excess water in the chambers would be pumped out to locations agreed with BAS Estates, BAS Operations and BAS Environment Office.

Figure 4-1 Water-filled Chambers at Rothera

Scenario B:

Defrosting of ducts and chambers would occur as described above.

If the defrosting is unsuccessful then ducting would need to be replaced. To replace ducting, trenches would be excavated, and material stored nearby for backfilling once the ducting has been replaced. Ducts would be disposed of as per the RUNSUR SWMP. For the approximately 270 m of affected ducting (between P04 and the AGL kiosk, and between P05 and the SWS on the western side of the runway), approximately 2,500 m^3 material would need to be excavated.

[18] Flowplant, 2024. Duct Desilting Brochure

In the event of any further erosion or settlement, or if the defrosting and sealing of ducting is unsuccessful, then the ducting in the five trenches providing future ducting capacity would be replaced. This would involve the excavation of approximately 1,000 m^3 of aggregate from the trenches which will be placed in proximity to the excavated area temporarily, then backfilled into the trench once the ducts had been replaced. It is important to note that this activity would mandate the closure of the runway and is therefore highly unlikely to take place. This activity has been included in this IEE due to the programme change requiring these works to be conducted in the next two years.

In addition to the frozen ducts listed above, four ducts from the western side of the runway were also found to be flooded during the 2022 – 2023 Season. These will be replaced during the 2024 - 2025 Season. This activity requires minor works comprising excavation, maintenance, and backfilling.

4.3.3 Waterproofing Flooded Chambers (early December 2024)

Maintenance work is required at the runway to rectify issues to chambers caused by ice damage. The works require the excavation and backfilling of flooded below-ground infrastructure, Figure 4-2.

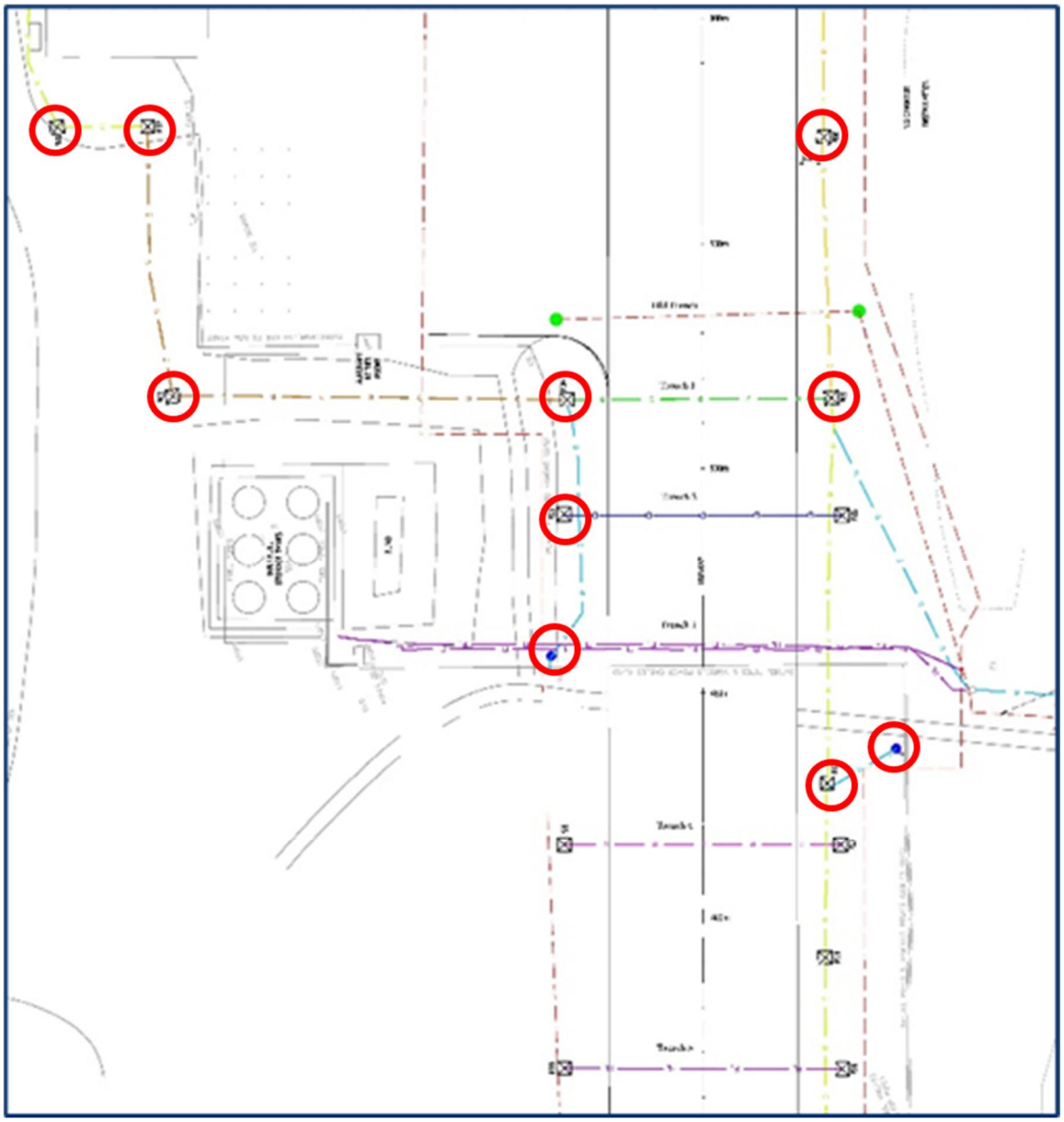

Figure 4-2 De-icing and waterproof sealing of 11 Runway Chambers (indicated by a red circle) and de-icing of ducts underneath the runway

There are five trenches that run across the runway, in addition to ducts that connect to the Hangar and traffic lights on the east and west crossing points of the runway. These ducts are held in large chambers which are located underground. Eleven precast concrete chambers associated with the AGL lighting were found to be flooded during inspection in the 2023 - 2024 Season. To resolve the flooding issue, holes varying between 150 mm and 300 mm in diameter will be sealed with grout (approximately 1.5 m^3 total of grout will be used across all chambers) and marine plywood. At this stage it is envisaged that sealing can take place from within the affected chambers. However, if this is unsuccessful then a total of approximately 1,100 m^3 of material may need to be temporarily excavated and placed to the side of the work areas surrounding the affected chambers to allow access to seal holes. If excavation is required, material would be backfilled around the chambers once the chambers have been defrosted and sealed with grout.

4.3.4 Flooded Duct Replacement (mid-January 2025)

An approximate 70 m long trench will be excavated between runway chambers P03 and P02 and the four flooded ducts will be removed and replaced with new ducting. Excavated material (approximately 800 m^3) will be temporarily stored adjacent to the work area and all of it used for backfilling once the ducting has been replaced.

If the material excavated from trenches is deemed unsuitable to be backfilled, material currently stockpiled to the east of the runway for backfilling of the area around the Discovery Building would also be required to backfill the trenches. Any unsuitable material removed from the trenches would be crushed and processed to be used as required for runway maintenance material (see Section 4.3.1 ‘Managing Defects from 2023 - 2024 Season’) and stockpiled on the western side of the runway (Stockpile 4).

4.3.5 Removal of Processed Aggregate (early January 2025)

As stated in Section 3.4.3, this activity comprises moving processed material from south of the Hangar, which was laid there during the 2019 - 2020 Season. This material would be relocated, and the ground would be reprofiled to level the ground south of the Hangar. This would be undertaken during early January 2024.

All of the aggregate, approximately 2,000 m^3, would be removed and relocated to the stockpile on the western side of the runway (Stockpile 4), adjacent to the balloon launching facility for future runway maintenance (see Section 4.3.1 ‘Managing Defects from 2023 - 2024 Season’).

The exposed ground would then be regraded to the levels of nearby runway chambers P01 and P02. Suitable material removed during the regrading work would then be processed at an agreed location with BAS Operations.

4.3.6 Processing Trench-Dug Material (January 2025)

During the reinstatement of the runway trenches during the previous 2023 - 2024 Season, approximately 500 m^3 of the material removed was considered unsuitable for backfilling and was consequently temporarily stockpiled on the western side of the runway.

This material is now scheduled to be crushed, along with any additional unsuitable material from the ducting repair trenches, Section 3, which is anticipated to be approximately 2,000 m^3.

After crushing, the material would be processed for future runway maintenance (see Section 4.3.1 ‘Managing Defects from 2023 - 2024 Season’) and stockpiled on the western side of the runway (Stockpile 4), to the south of the balloon launching facility. This activity therefore comprises crushing, processing, and moving of material.

4.4 Rothera Modernisation Project (RMP)

The RMP project requires excavation and stockpile movements for the activities included within this section. The materials movements for the RMP project are included in Table 4-2, which includes both activities approved in the original RMP IEE 2019, and new activities listed in this IEE. For all activities that require stockpiled material, the volume of stockpile material to be used will be set out in a Stockpile Management Plan, and the amount of material taken from the stockpile will be recorded at the time, see Section 5.5.

Table 4-2 RMP Material Movement

No.	Activity	Location	Expected Volume (m^3)
2024 – 2025 Season			
1	Excavating, remediating, and spreading fill or fine material on roads.	Rothera	50
2	Excavating, remediating, and spreading fill or fine material on paths.	Rothera	10
3	Excavating, remediating, and spreading fill or fine material as laydown platforms.	Rothera	30
4	Excavating fine material used to build the Discovery Crane winterisation platform.	Rothera	5
5	Placing fine material used to build the Discovery Crane winterisation platform	Rothera	5
6	Excavating and backfilling for the below ground drainage installation between Admirals to the STP	Discovery Building	30
7	Excavating and backfilling for below ground drainage installation between the Discovery Building to the STP	Discovery Building	400
8	Excavating and backfilling for the drainage lines from the SWS gantry to Manhole 1 including three lines of foul drainage: Bonner Laboratory, Giants House, and one Spare.	Discovery building	50
9	Excavating and backfilling for the below ground earthing for the Discovery North Yard Concrete Slab	Discovery Building	100
10	Excavating and backfilling for the below ground service ducts for the Discovery North Yard Concrete Slab	Discovery Building	10
11	Placement of fill materials for external concrete slabs in the North Yard and eastern elevations	Discovery Building	5
12	Placement of remaining fill materials to the Discovery North Yard Concrete Slab.	Discovery Building	1,300
13	Excavation and transferral of processed fill material from stockpiled locations when required	Discovery Building	10,000
14	Remedials / snagging works for the SWS blocks	Discovery Building	20
15	Processing of fill material with screener to extract fines to be used to backfill the seawater and foul drainage runs from the Discovery Building to STP. Fines are to be taken from Type 1 stockpiles.	Discovery Building	240
16	Excavating trenches and backfilling from SWS at BAM workshop to the east of the IWHF. SWS were originally going to be buried in middle of road between STP and BAM workshop. SWS now proposed to be buried to the east of the BAM Workshop coming off the Gantry. Three ducts to be buried for power and FA to IWHF.	Discovery Building	20
17	Excavate, replace, and backfill frozen ducting from the Hangar to the Runway *(only to be employed if jet water activity does not work).*	SWS	510
18	Excavate, replace, and backfill frozen ducting from the Runway to BAM Fitters Workshop. *(only to be employed if jet water activity does not work).*	SWS	150

19	Excavate and backfill around eight RUNSUR chambers. The areas around the manholes have to be excavated to allow waterproofing to be undertaken. Fill will be stored following same material storage guidelines as when they were installed. No excess fill is expected.	RUNSUR	144
20	Excavate and bury ducting from Vikings House to Bentham House.	SWS	30
21	Excavate, reprofile ground, and place fill material for structures between SWS Run A and the STP.	SWS	30
22	Excavate, place multiduct and backfill material from Bonner Laboratory to Gerritsz Road crossing.	SWS	100
23	Excavate, reprofile, place fill for concrete structures from the Bonner Laboratory to the Seawater Pump House.	SWS	20
24	Removal of existing services to the Bonner Laboratory.	SWS	50
25	Excavate, reprofile, and place fill material for Bonner Laboratory blocks.	SWS	100
26	Excavate, reprofile ground, and place fill material for concrete blocks for the SWS strengthening works.	SWS	100
27	Providing power to the ARIES Dome from the Communications Container adjacent to the Bentham Container.	SWS	60
28	Reprofiling the straight road between Admirals to the runway crossing into a curve to prevent a potential safety risk.	SWS	2,000
29	Temporary South Access Road to the south of the Discovery Building.	Discovery Building	30
30	Sand pipe bedding for the foul and greywater drainage system.	Discovery Building	40
Total 2024 – 2025 Season			15,639 m^3
2025 – 2026 Season			
1	Excavating, remediating, and spreading of fill/fine material on roads.	Rothera	50
2	Excavating, remediating, and spreading of fill/fine material on paths.	Rothera	10
3	Excavating, remediating, and spreading of fill/fine material as container laydown platforms.	Rothera	30
4	Excavating fine material used to build the crane winterisation platforms.	Rothera	5
5	Placing fine material to build the crane winterisation platform, assuming at least one crane is retained.	Rothera	5
6	Placement of remaining fill materials to the Discovery Building platform.	Discovery Building	1,300
7	Excavation and transferral of processed fill from stockpiled locations, as required.	Discovery Building	10,000
8	Strip-out and deconstruction of existing BAS assets, including the removal of foundations (including likely presence of asbestos) and reprofiling of ground levels.	Discovery Building	2,000
Total 2025 – 2026 Season			13,400 m^3

4.4.1 Excavating, Replacing and Backfilling Frozen Ducts (December 2024 – January 2025)

This proposed activity would comprise remedial works, namely rectifying issues from water ingress and freezing at previously installed below-ground infrastructure with water jetting equipment, and potentially excavating these ducts should the water jetting be unsuccessful.

Previously installed ducts have frozen at two ducting routes: Hangar to Runway; and Runway to Fitters Workshop. Specialist jet equipment that is typically used for cable duct desilting will be used to defrost the frozen RMP ducting (see Section 4.3.2 for more information). This equipment is capable of pumping approximately 500 litres of seawater per hour, and this will be heated if required. The chambers will then need to be waterproofed by excavating holes varying between 150 mm and 300 mm in diameter and sealing these with grout (approximately 1.5 m^3 total of grout will be used across all chambers) and marine plywood. If the defrosting technique is unsuccessful, then an excavator would dig 3 m wide by 1 m deep trenches, and approximately 170 m long for Hangar to Runway, and 50 m long for Runway to Fitters Workshop. The excavated material, see Table 4-3, would be temporarily stored alongside the trenches. The ducts to be replaced are detailed in Table 4-4.

The frozen ducts would be removed, replaced with new and waterproofed, and excavated material would be backfilled. No excess material is expected as this area has been previously excavated to lay ducting. A whacker plate or roller would be used to compact the area to the same profile as before this activity. This activity would require four to six personnel. The initial defrosting of the ducting would occur between 3rd – 20th December 2024 and if required, the ducting repairs are scheduled for 14th – 23rd January 2025.

Table 4-3 Area of Excavated Material for Each Location

Location	Width	Height	Length	Volume
Hangar to Runway	3 m	1 m	170 m	510 m^3
Runway to Fitters' Workshop	3 m	1 m	50 m	150 m^3

Table 4-4 Number of Ducts Required to be Replaced

Location	Ducts
Hangar to Runway	5 x 150 mm
Runway to Fitters' Workshop	5 x 150 mm

The methods to defrost, and if required excavate, will follow the RUNSUR scenario-based methods which are presented fully in Section 4.3.2. Defrosting measures are set out in Scenario A, and dependent on the success, excavation and replacement of damaged ducting measures are set out in Scenario B.

4.4.2 SWS Excavation Activities (between November 2024 – January 2025)

For all activities that require stockpiled material, the volume of stockpile material to be used will be set out in a Stockpile Management Plan, and the amount of material taken from the stockpile will be recorded at the time, see Section 5.5. Each of the below activities will require an excavator, whacker plate and up to 3 no. BAM staff to complete.

<u>BAM Fitters Workshop to Interim Waste Handling Facility SWS Re-Route</u>

This activity would comprise trench excavation and backfilling of material in order to lay below ground infrastructure (ducting and service lines), between the SWS at the south-east corner of the BAM Fitters Workshop and the IWHF. The activity would re-route existing services along the eastern elevation of the Fitters Workshop. This activity was not included in the original RMP IEE as it was envisioned that the WHF would be decommissioned prior to the completion of the RMP Project.

Vikings House to Bentham Container Ducting

This activity comprises the filling of previously disturbed ground. The SWS between Vikings House and Bentham Container currently sits atop concrete blocks. These blocks are subject to extra snow loading given their location, which has the potential to damage the SWS. Approximately 30 m^3 of fill will be used to bring the immediate area surrounding the eight concrete blocks up to level with the concrete blocks, spreading the snow load onto the surrounding area. This activity will require an excavator, whacker plate and up to 3 no. BAM staff to complete.

Bonner Laboratory to Gerritsz Laboratory SWS Rerouting

The SWS were initially proposed to run along the ridge to the east of the Gerritsz Laboratory. However, as with the above item, the BAS Estates team have noted that this alignment would be at risk of structural damage caused by excessive snow loading along the ridge. As a result, the services are now proposed to be re-routed along the eastern elevation of the Bonner Laboratory. The earthing connection points will be exposed using a combination of machine excavation and hand digging when in close proximity to the earthing strip.

Several concrete blocks which have been redesigned to minimise snow loading would therefore be positioned along the route for the SWS to sit atop. This re-routing would also comprise the excavation and backfilling of rock, to lay parts of the rerouted SWS below ground at the Gerritsz road crossing. Excavation work would also involve reprofiling the ground in preparation for construction of the SWS. Existing services routed into Bonner Laboratory would be removed as waste and disposed of in line with the RMP SWMP.

Bentham Communications Container to ARIES Dome Power Cable

As the OBH is due to be decommissioned in April 2025, (see Section 4.4.9), a new power source is required for the ARIES Dome. This would be drawn from the existing Bentham Communications Container, approximately 40 m east of the ARIES Dome. This activity would require trenching a new route to the Bentham Container and backfilling the material into the trench once a new cabling route has been laid. BAS Estates would lead this work. This activity will be completed by 2 no. BAS Estates using an excavator.

4.4.3 Connecting Admirals and Discovery Building to the STP Drainage Installation (January – February 2025)

New drainage routes would connect Admirals Building and the Discovery Building directly to the STP, as well as providing connections for Bonner Laboratory and Giants. The activity would comprise trench excavation, laying below ground infrastructure and backfilling of the excavated material. Type 1 stockpiles would be screened to remove dust, providing a layer of fine dust utilised for pipe bedding. Approximately 500 m^3 of material would need to be excavated and backfilled. Any spare material would be stockpiled at a location determined by BAS.

This activity was originally listed in the RMP IEE 2019 but could not be undertaken due to a lack of available resource during the 2023 – 2024 Season. While the original methodologies as set out in the RMP IEE 2019 remain the same, the current scope includes some additional drainage connections from the STP to the Discovery Building and is therefore included for reassessment in this IEE.

4.4.4 Earthing and Service ducts within Discovery North Yard (February 2025)

This activity would comprise excavation and backfilling of previously disturbed material for the installation of below ground infrastructure: earthing and service ducts would facilitate external heated concrete slabs in Discovery Building's North Yard. This work was omitted from the original RMP IEE 2019.

Earthing is required to safeguard the building from an electrical standpoint, while the ducting would heat precast concrete slabs with hot water channelled through a network of ducts, in order to melt snow accumulation and maintain access to the Discovery Building's northern elevation, as well as reducing snow management requirements.

A series of trenches would be excavated for the earthing and service ducts, removing approximately 150 m^3 of material which would be backfilled once ducts have been installed.

4.4.5 Installing an external slab with fuel tank to the eastern yard of Discovery Building (February 2025)

This activity forms part of the Discovery Building's external slab and earthing arrangement at its north-eastern side. The proposed activity is required to deliver the agreed final design and capability delivery of the Discovery Building as required by BAS.

Enabling works were begun in error during the 2023 – 2024 Season, with a 10 m (long) by 1 m (wide) by 0.7 m (deep) trench dug at the north-eastern perimeter of the Discovery Building, removing 7 m^3 of material, which was temporarily stored adjacent to the works zone. The trench was CAT scanned, then opened using a mechanical excavator before being hand dug when near the edge of the building. The activity had incorrectly been brought forward as an opportunity by BAM without a Section 6 permit being assigned and without the activity being communicated to the BAS supervision team. Once noted by BAS, the activity was halted immediately and reported back to the UK for further instruction. The trench was also refilled.

During the upcoming season, it is proposed that two operatives will re-dig the trench at the required location along the north-eastern perimeter to expose the earthing connection points at the foot of the Discovery Building. The additional material excavated will be temporarily placed adjacent to the trench while the works are undertaken. The 25 mm by 3 mm copper earthing tape will then be buried and tied to two locations on the existing concrete foundation pads. The trench will then be backfilled and compacted using a whacker plate to achieve the desired compaction, Figure 4-3.

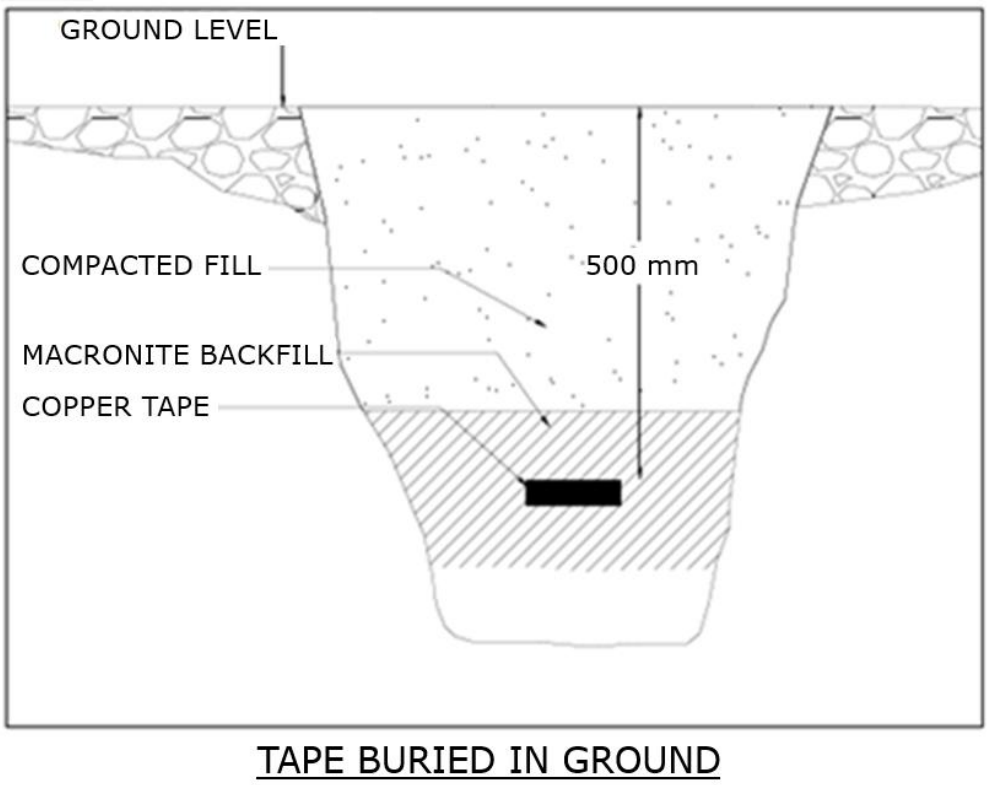

Figure 4-3 Trench Backfilling and Compaction

This proposed activity also comprises the installation of a refuelling tank to the north-east corner of the Discovery Building. This would be preceded by the deposition of approximately 6 m^3 of material taken from Admirals stockpile, laid down with an excavator and compacted using a whacker plate or roller. The compacted material would then receive a layer of fines material, extracted from the fines stockpile adjacent to the BAM Fitters Workshop.

A 4.6 m by 2.45 m precast concrete slab would then be lifted into position and levelled using a BAM excavator. The new fuel tank will have a capacity of 5,000 l and will replace the existing vehicles refuelling tank located outside the Rothera vehicles garage. The tank is bunded (double-skinned) in order to prevent any leakage into the local environment. It is also fitted with a high-level alarm for further protection against over-filling. There is also a bund alarm which will alert personnel in the event that fuel is present between the two skins of the tank, Figure 4-4.

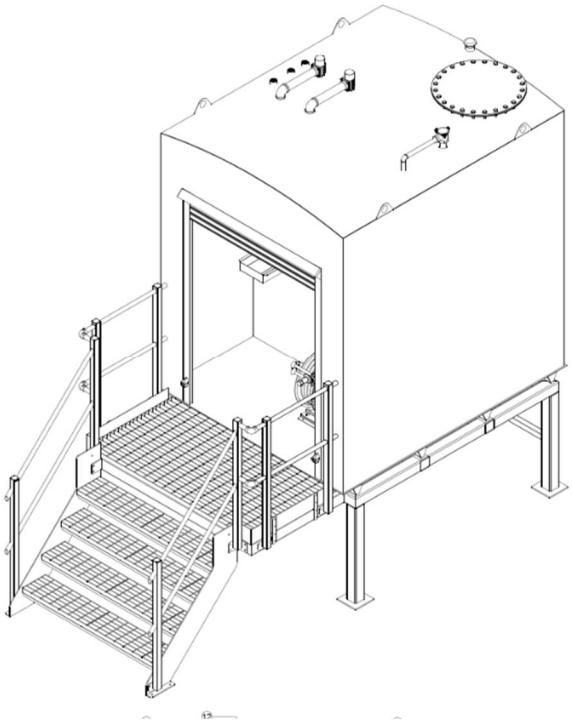

Figure 4-4 Rothera New Fuel Tank

4.4.6 Reprofiling road between Admirals to Runway Crossing (TBC)

The requirement for this proposed activity was raised by BAS Station Operations at the end of the 2023 – 2024 Season. While compliant with UK road legislation, the current gradient of the runway crossing access road, established during the previous 2023 – 2024 Season between Admirals building and the runway crossing, was found to pose a potential risk. The BAS Station Operations have raised concerns that the gradient has the potential to cause vehicles travelling along the road to skid onto the runway when ice is present. At the time of writing, the BAS wintering team are monitoring the situation and have not found any issues. This item has been included in the IEE should issues arise in the 2024 – 2025 Season and must be rectified as a matter of urgency.

This activity will not involve excavation but will use existing rock material around the current road alignment to reprofile the road before being compacted. No additional material would be sourced from stockpiles. The updated gradient would be decided at the start of the 2024 – 2025 Season but would comprise a gradient which is deemed acceptable to Rothera operations.

Further information is required to understand whether this part of the access road poses a safety risk and would require groundworks to remedy the gradient, and feedback is due to be provided during this 2024 austral winter. The proposed activity is included in this IEE on a precautionary basis.

4.4.7 Temporary South Access Road to Discovery Building

The activity described in the IEE is to provide access to the south side of the building whilst other works are being undertaken in the north yard. Once the demolition of the old buildings occurs, including the garage and the generator shed (currently planned for the 2025 - 2026 Season) then the area to the south of the Discovery will be reprofiled as part of the demolition activities. The access road will then be reprofiled as part of these activities.

The Temporary Access Road will take approximately 1.5 days to complete, with an estimated 30 m^3 of rock to be moved. No additional rock will need to be sourced or processed from existing stockpiles, as the rock material from the immediate surrounding area south of Discovery Building will be moulded into the shape of an access slope / platform.

4.4.8 Strip Out of Existing Assets (November 2025 – December 2025)

'Soft Strip' deconstruction refers to the process of removing certain internal elements of a building while preserving the structure and outer shell, in preparation for a full deconstruction. The proposed soft strip out works would require six staff (including an asbestos specialist as asbestos[19] is likely to be present). Tasks would include clearing the OBH yard, placing 12 ft by 20 ft shipping containers for waste storage along the east elevation of OBH to establish a temporary enclosure, creating access routes to allow filling of containers and clearing the OBH stores and office spaces to act as a waste segregation space during the strip out activity. After a shipping container has been filled with waste it will be transported to the designated container storage area and replaced with an empty container to continue the strip out process.

The soft strip out activities would include clearance of all BAS items from the buildings; ensuring existing service supplies to buildings have been isolated; draining and flushing of wet services; managing wet wastes (such as water, coolants, fuels); and commencing strip out activities (internal finishings, doors, non-load bearing elements, and mechanical and electrical elements).

4.4.9 Deconstruction of Existing Assets (December 2025 – February 2026)

This proposed activity comprises the excavation of the foundations of the legacy buildings, reprofiling ground and placement of fill derived from previous activities to backfill the sites, as well as moving the waste material across the site for collection at the wharf. This activity will follow the soft strip activities.

This activity was initially assessed and approved in 'Deconstruction and Decommissioning of Existing Buildings' in Section 4.6 of the original RMP IEE 2019. Step 21 in the proposed sequence of deconstruction stated that 'the principal for the foundations is to leave all embedment's below the new ground level in place. They will be recorded and surveyed for future reference.'

However, for the proposed scope of works covered by this IEE it has been decided that the foundations of the deconstructed buildings would be dismantled, removed and the ground reprofiled. It is envisaged that approximately 2,000 m^3 of material will be reprofiled as part of this activity. There is no stockpile material allocated to this activity, as the amount of backfill material re-used from the excavations is considered sufficient provided that the ground is reprofiled.

The deconstruction will generate waste materials as detailed in Section 7.5. Concrete and other materials would be removed and broken up using a road saw and breaker. All waste materials not suitable for reuse at Rothera or the other BAS locations would be stored in containers for shipping back to the UK. At present, there is an estimated 3,000 m^3 of waste materials from legacy buildings requiring removal from site.

It is anticipated that a commercial vessel would dock at the wharf in March 2026 to remove deconstruction waste relating to these works, as well legacy waste from Biscoe Wharf deconstruction, which was approved as part of the Rothera Wharf CEE 2018[20]. See section 4.4.10.

4.4.10 Removal and Containerisation of Waste, Removal of Containers from Rothera, and Reprofiling of Ground (2025 – 2026 Season)

It is anticipated that a commercial vessel will dock at the wharf to take RMP deconstruction waste from Rothera back to the UK for processing and disposal in March 2026. This will also include legacy steel waste from the former Biscoe Wharf, which is currently stored at the North Cove beach. The waste steel may need to be cut into suitable sizes at the wharf.

[19] Once presence of asbestos is confirmed, applicable practices for removal and waste consignment will be used in consultation with the BAS Environment Office.

[20] British Antarctic Survey, 2018. Rothera Wharf Reconstruction and Coastal Stabilisation – Final Comprehensive Environmental Evaluation. Available at: Microsoft Word - Final CEE Rothera Wharf Reconstruction & Coastal Stabilisation 05.09.18.docx (bas.ac.uk)

The waste container areas are currently sitting on stockpiles of aggregate, earmarked for the RMP project. Reprofiling will be required at these sites to return the ground to its previous condition, following the removal of the containers and the clearance of the aggregate. Some areas will require minimal reprofiling to make the area in keeping with the surrounding location.

With regards the Biscoe Wharf waste at North Cove Beach, there are two options being considered for the removal of the waste, dependent on the type of commercial vessel commissioned:

- Bulk Cargo Transport: loading the waste onto trucks and transporting to the wharf to be craned into bulk carrier ship. No containerisation would be required; or
- Containerisation: waste steel must be cut into suitable sizes at the wharf before being containerised and loaded onto a container ship.

4.5 Very Low Frequency Equipment Relocation

The VLF hut has been prefabricated in the UK and will be shipped to Rothera dismantled, where it will be re-built at the new location. Cargo for a new hut to accommodate the VLF equipment is anticipated to arrive at Rothera on the SDA in November 2024, though the exact timing of the construction and commissioning is yet to be scheduled for the 2024-2025 Season programme.

The proposed activity would initially comprise the moving of materials from the wharf in late November 2024. The new VLF hut materials would first be transported via trailer attached to a skidoo to the top of the point, below the ASPA. At this point, the trailer would be attached to ropes, detached from the skidoo, and lowered down to beach level as this is part of the route is too dangerous to traverse by skidoo. Once on East Beach, the materials would be carried to the proposed new VLF hut relocation site.

Three BAS Estates staff are resourced to undertake the installation of the hut. The site (approximately 3 m x 2 m) would be cleared and levelled by hand. Up to eight gabion basket foundation piers would be installed and filled with locally sourced rock by hand. The new VLF hut would be assembled on the gabion foundations from modular panels, Figure 4-5, using small impact drivers/wrenches/sockets, and would measure 2.8 m x 1.9 m in total.

There is no spare electrical capacity in NBH, where the energy for the EBH structures is presently supplied from, without upgrading the main panel. Therefore, any new electrical connections are to be via the Discovery Building, if required.

The new VLF hut would then be connected to the EBH via a new above-ground 48v cable, which would not be buried or trenched. Finally, additional cabling would be laid to connect the VLF equipment within the hut with the VLF antenna, which will remain at its existing location upon the ridge.

The VLF equipment relocation programme can be summarised as follows:

- Mid November 2024: The SDA arrives at Rothera to unload VLF Hut materials;
- Late November 2024: The new VLF hut materials will be relocated to the site at East Beach;
- December 2024 / January 2025: A BAS Engineer and two Carpenters to undertake new hut construction;
- January / February 2025: New cables installed;
- Mid-February 2025: VLF equipment relocated to the new hut;
- Late February 2025: The new VLF hut is commissioned;
- Early March 2025: The new VLF hut is operational; and
- April 2025: The OBH (location of existing VLF equipment) decommissioned (see RMP activity: Deconstruction of Existing Assets, in Section 3 and Section 4).

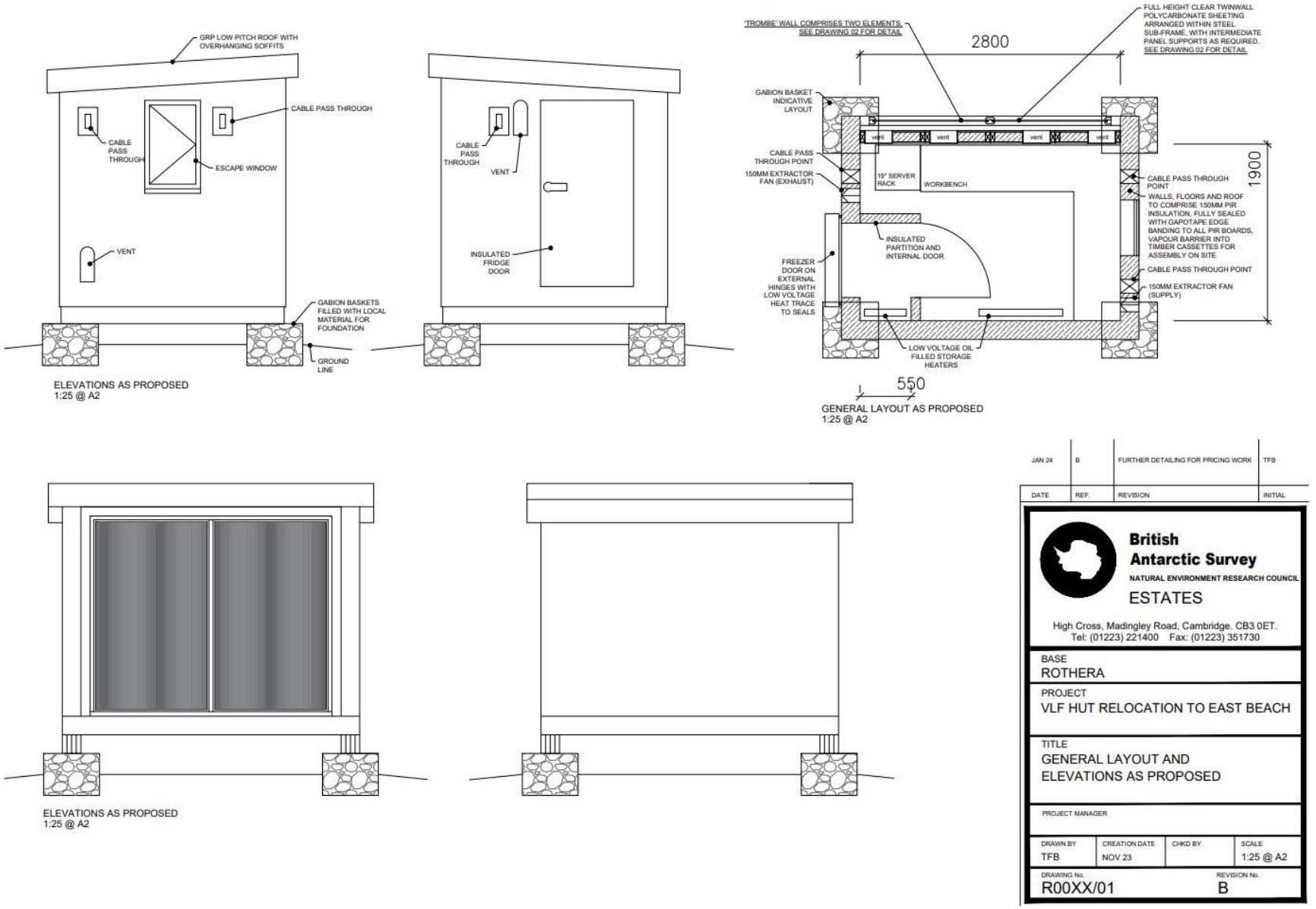

Figure 4-5 New VLF Hut Layout Plan

4.6 Decommissioning Plan

Following the completed works it is considered that the installations will remain in operation until they are no longer fit for purpose, or if there is a change in BAS operations at Rothera. In the event of changed operations at Rothera, any structures introduced as part of the scope of this IEE would be subject to a more detailed assessment at the time of decommissioning. As with the scope of this IEE, buildings to be dismantled shall be scope activities in their own right, to be included within future IEEs.

Full detail will be explored and provided at the appropriate time, although at this stage, should decommissioning take place, it is assumed that any cabling and infrastructure (above and below ground) would be removed according to best practice at the time. The aspiration for decommissioning of infrastructure is incorporated into construction design, allowing buildings to be dismantled in a way that allows the site to return to a suitable condition. The opportunity for reuse, recovery, and recycling of materials will be explored. If this is not possible, waste will be minimised as far as reasonably practicable.

5. SUPPORT ACTIVITIES

5.1 Shipping and Air Freight

5.1.1 Cargo

Transport of construction equipment and plant (including permanent materials, temporary works, and equipment) would be undertaken by the SDA, from supply hubs in the UK to Rothera, Figure 5-1. The environmental monitors are due to be delivered on the early aircraft prior to the beginning of the season, however this date has not been confirmed at the time of witing. Although the final schedule for SDA visits to Rothera has yet to be confirmed, it is anticipated that these will include the following approximate dates:

- 19th November 2024 - initial field input, majority of construction staff arrive, as well as delivering required cargo and equipment items, such as the new hut to accommodate the VLF equipment.
- 25th December 2024 – 21st January 2025 - additional field uplifts when some construction staff will be replaced.
- 2nd May 2025 - departure for small amount of construction staff.
- 17th May 2025 - departure for the majority of construction staff.
- 17th June 2025 - final departure for the 2024 – 2025 Season.

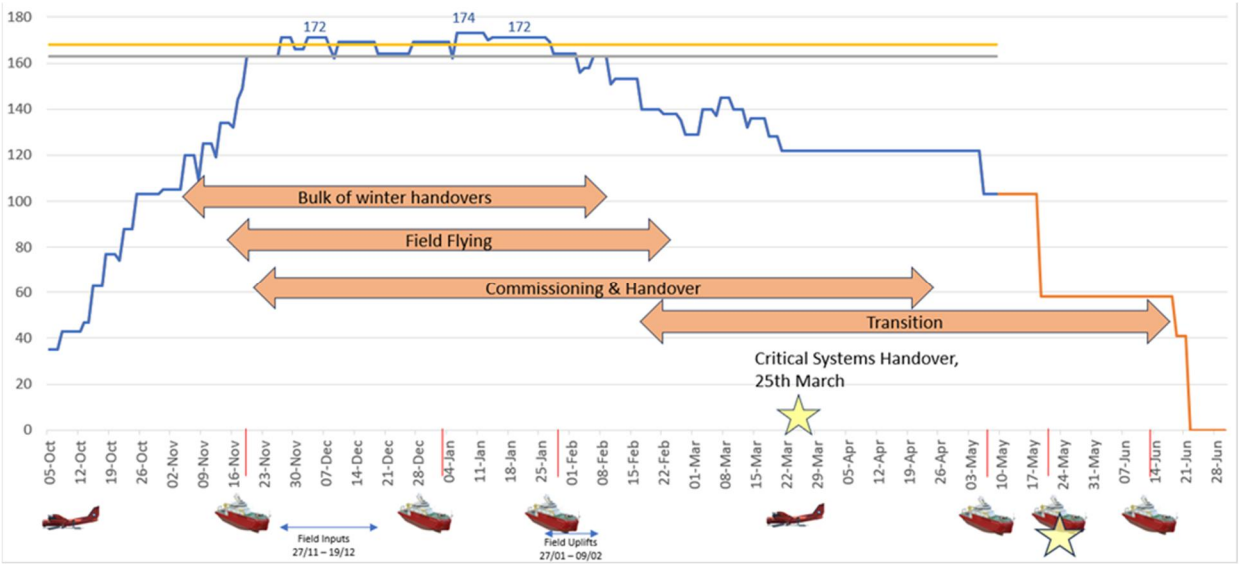

Figure 5-1 Rothera personnel numbers planned for 2024 – 2025 Season

Additionally, the following season, in March 2026 it is anticipated that a commercial vessel would be required to dock at Rothera to transport deconstruction waste generated by the strip-out and deconstruction of decommissioned BAS assets as part of the RMP project. The vessel will transport waste from Rothera back to the UK for processing and disposal. This would also include legacy waste from the past Biscoe Wharf, the deconstruction of which was approved as part of the Rothera Wharf CEE.

Prior to and during loading for both SDA and commercial vessels, biosecurity measures as outlined in the project-specific biosecurity plans would be followed, as well as measures outlined in the BAS Biosecurity Regulations (2023)[21]. For further detail on biosecurity measures, see Section 7.7.

[21] British Antarctic Survey (Environment Office), 2023. BAS Biosecurity Regulations. Available at: BAS-Biosecurity-Regulations.pdf

5.1.2 Personnel

Personnel will be transported to and from Rothera either by sea or by air (Figure 5-1). Personnel would fly from the UK to the South Atlantic gateways, using established scheduled flights. Most personnel would then fly to Rothera on the BAS Dash 7 aircraft from Punta Arenas in Chile; however, some may fly from the Falklands Islands. Specific personnel numbers are included in Section 3.8 earlier in this document. All cargo and personnel will adhere to the necessary biosecurity procedures and requirements.

5.2 Accommodation

All personnel will continue to be housed in either the existing permanent accommodation at Rothera (Admirals House or Giants House) or within Vikings House.

5.3 Energy Use

Electrical power at Rothera has been provided by four Volvo TAD 752GE diesel engines, coupled to AC generators housed in the generator shed, producing 144 kW. From these, the 24-hour continuous power has been provided by two of the Volvo TAD 752 GE diesel engines. The 24-hour continuous power is provided by having two online at any time but with an automated means of changing over from one set to another. There are two mobile generator sets Volvo TAD 752GE which can be plugged into NBH or the Bonner Laboratory. There is an auxiliary power container behind the Hangar housing Cummins generators for emergency purposes to power the Hangar. Power usage is minimised wherever possible and any equipment to be installed at Rothera that requires electrical power must be approved through the planning process prior to installation.

However, once the Discovery Building is operational, from the end of April 2025, Rothera will instead be primarily powered by four new Combined Heat and Power (CHP) engines, successfully installed at the ground floor of Discovery Building in April 2024. Thus, electricity at Rothera will be supplied via the CHP engines, plus small amounts from the solar PV panels installed on the exterior of Discovery Building. Thermal generation would be via the CHP engines, as well as two Marine Gas Oil (MGO) boilers, plus a small amount from the solar thermal and PV panels on various buildings at Rothera.

Rothera requires on average 700 m^3 of MGO per year to maintain serviceability. Approximately 66% is required for power production, 29% for heating generation, 3% for vehicles and 2% is used to supplement the waste incinerator.

Most of the heating is supplied in conventional heating systems, oil boilers in larger buildings and electric heaters in small buildings. The larger buildings are also equipped with air handling units. Rothera uses on average 180 kW to 200 kW of power and any one time.

Rothera has several energy efficient measures in place:

- Heating controls and temperatures are closely monitored to improve efficiency;
- Power is monitored and reduced where practicable;
- Energy efficient lighting;
- Greater use of natural lighting; and
- Building Management System (BMS).

Power generation for all construction activities, (excluding meals and accommodation for the construction personnel), will be provided independently to normal BAS operations.

BAS have a target for Rothera to become a zero emissions station by 2030, and therefore is seeking alternative ways to support ongoing operations at Rothera through the incorporation of additional renewable energy infrastructure, see Section 3.4.1.

Power usage is minimised wherever possible and any equipment to be installed at Rothera that requires electrical power must be approved through the planning process prior to installation. All staff will be briefed on the importance of reducing energy consumption at Rothera and briefed on simple measures to achieve this objective including:

- Avoid using heating when windows are open;
- Turning lights off when not in use;
- Only use full washing machines on the economy setting where possible;
- Use drying rooms rather than tumble drier when possible; and
- Maximum of three minutes of running water per shower.

5.4 Water

5.4.1 Water Usage

BAS will provide all domestic and construction fresh water required for projects, generated by the onsite reverse osmosis (RO) plant. Fresh water is produced at Rothera by RO, filtering salt water to create fresh water through a process of desalination. The RO plant is online 24-hours a day and can produce up to 24 m^3 per day. Water is readily available unless there is a mechanical failure. Efficient use of water is encouraged to minimise fuel use.

In addition, a new potable water system is due to be commissioned in January 2025 at Rothera. This will utilise new potable water installations (e.g. water tanks) and a distribution system at Discovery Building, as well as the SWS network. The new Discovery Building will operate two RO plants.

Potable water is stored in the RO room which currently has three tanks with a total volume of 28 m^3. This water is then pumped to smaller satellite tanks situated in other buildings. A melt tank is also available for emergency use. Salt water is used in three buildings for flushing toilets when potable water supply is low, however this requires the STP to be bypassed as saltwater has a negative effect on the bacterial reaction within the plant resulting in the failure to properly break down the sewage from station. Station operations aim to remain on potable water as much as possible and it is only due to situations such as mechanical failure or peak usage where saltwater is used.

Once the Discovery Building's RO plants are online, toilet flushing will be switched to potable water full time to improve operation of the STP. Freshwater is already being used to improve efficiencies in the STP, which are much needed given its increased use through the construction periods of the 2024 – 2025 and 2025 – 2026 Seasons. The Station Leader will remind all personnel to keep water usage to a minimum, particularly in summer when there are more people at Rothera.

Water usage associated with the presence of personnel at Rothera fluctuates throughout the year due to varying numbers present; between March to September average potable water use is 70 m^3 per month and average saltwater use is 30 m^3 per month (21 personnel), whereas between October to December average potable water use is 200 m^3 per month and average saltwater use is approximately 90 m^3 per month (70 - 90 personnel average).

There will be higher than usual potable water requirements due to additional site personnel at Rothera. In addition, a new potable water system is due to be commissioned for the Discovery Building and SWS in January 2025 at Rothera. This will utilise new potable water installations (e.g. water tanks) and a distribution system at Discovery Building, as well as the SWS network.

All staff will be briefed on the importance of reducing water consumption at Rothera. Activities will be conducted in a way that minimises water consumption as far as reasonably practicable to ensure water and energy associated with its creation is used efficiently. Wherever possible, sea water will be used for construction activities such as dust suppression.

For the RUNSUR project, the defrosting of ducts using jet equipment requires significant volumes of water (approximately 500 litres per hour); this activity would use sea water as it would not be possible with the equipment on site to produce sufficient quantities of fresh water. The remainder of the runway resurfacing activities that require fresh water are estimated to need no more than 2 m^3 of fresh water for mixing and some cleaning requirements. No additional fresh water is expected to be required for any of the other activities in this IEE. Water usage will be reported at the end of each season and as per project-specific Site Management Plans. All potable water used for construction purposes will be recorded and reported to BAS.

5.4.2 Flushing/Cleaning of the LTHW System

The new LTHW systems that have been installed in the Discovery Building heating system, Energy Centre CHP Systems and District Heating Circuit, may require flushing and cleaning before commissioning. In the UK, this is an established process by which the entire LTHW network would be flushed with a cleaning solution and any contaminated flushed water would typically be discharged into the mains drainage system, pending approval from the relevant UK water authority.

However, given the sensitive environment of Antarctica, additional environmental mitigation may be implemented, to prevent contaminated water being discharged into the sea, or to prevent contaminated water being sent back to the UK, at a large carbon cost.

Thus, two options have been set out for the purposes of this IEE. Permission is therefore sought to pursue both options in this IEE, as necessary. The chosen option will be selected at Rothera within the 2024-2025 Season and would be detailed in the subsequent PSER.

Option 1: Do-Nothing

The LTHW system will not be flushed. If contractors on site deem there to be an acceptable level of risk in not flushing the system, no further action will be taken.

Option 2: The LTHW System will be partly flushed with cleaning solution

- Isolate only the steelworks portion of the LTHW system, so that only the necessary portions of the network are flushed;
- The system will then be flushed with a solution of water, BOSS system cleaner and BOSS Commercial Inhibitor. This would require a quantity of 16 litres of cleaner, producing a volume of 4,000 litres of contaminated water at a 0.4% concentration. This contaminated water will then be stored in four 1,000 litres Intermediate Bulk Containers (IBCs) and kept inside a building on site to prevent freezing. This also prevents the need for large quantities of anti-freeze (which is typically required to enable storage externally), which would further contaminate the water; and
- Contaminated water will then be shipped back to the UK at the next available opportunity. If the flushing is completed in December 2024 or January 2025, then it is feasible it could be removed before the end of the 2024-2025 Season. It should be noted that the removal date from site would be dependent on BAS/BAM cargo priorities and availability, but every effort would be made to remove the contaminated water from Rothera at the earliest opportunity. To facilitate timely removal from site, it may be more suitable to transport the waste containers onboard the SDA, in which case BAM would be responsible for arranging port collection, transport and final disposal in the UK.

5.4.3 Sterilisation of Potable Water System

The new potable water systems, including the Discovery Building potable distribution and SWS network, need to be sterilised prior to commissioning. Unlike the LTHW systems, this process cannot be avoided due to the risk to human health if bacteria develop in the drinking water system. The following procedure is proposed:

- A hydrogen peroxide solution is proposed (Huwasan TR20) at a concentration of 100ppm, or 0.05% of the total volume of the system. This equates to 30 litres in total (22 litres of the hydrogen peroxide solution to sterilise the two 22,000 litres tanks, plus approximately 8 litres to clean the tanks). This would be captured, left to decompose for up to 24hrs and tested prior to disposal;
- The two 22,000 litres water tanks will be accessed and internally cleaned, base and sides wiped down with TR20. The RO plant will produce enough potable water to fill both tanks. The water systems will be filled and drawn through to all tap outlets;
- TR20 will be introduced to the system via injection points. The water and hydrogen peroxide solution will be stored within the water tanks for a minimum of 24 hours to allow the solution to naturally decompose into water and O_2;
- Water will then be pulled through to all outlets and tested with hydrogen peroxide test strips to prove 100 ppm has been achieved;
- As water is pulled through to all outlets, there is a risk that small quantities of active hydrogen peroxide could discharged into the drains and ultimately into the sea. This risk will therefore be managed in two ways:
    - Where the drains are connected to the Discovery Building sewage collection tank, the sewage tank pumps will be switched off and the collection tank will function as a hold point. The hydrogen peroxide solution will then be held in the sewage tank and tested to ensure the hydrogen peroxide has fully decomposed prior to eventual discharge to the sea via the STP. The Sewage tank will be cleaned and emptied (sewage system will not have been used prior) at the start of operation. The hydrogen peroxide content will be tested using test strips submerged within the water/hydrogen peroxide solution. The full breakdown of the H_2O_2 is expected within 24hrs; and
    - Where the drains are connected directly to seawater outfalls, a suitable collection vessel will be positioned/connected to the water outlet to capture all water as it is pulled through. This will then be held and tested, prior to disposal to sea once proven that the hydrogen peroxide has fully decomposed. The maximum expected quantity required to be collected is no more than 100 litres in total between three different sink outlets. The hydrogen peroxide content will be tested using test strips submerged within the water/hydrogen peroxide solution. Full breakdown is expected within 24hrs.
- Once it is confirmed that the hydrogen peroxide has fully de-composed, the water is then safe for human consumption and will be utilised for general potable water requirements in order to minimise waste and energy consumption.

Future tank cleaning and potable water sterilisation is ultimately dictated by BAS Estates' 'Water Quality Management Plan' (WQMP)[22], and will be managed by BAS Estates after the initial commissioning of the system. The BAS WQMP sets out the roles, responsibilities, processes, and procedures that BAS staff on station will apply to all water systems to control any identified risk from Legionella Bacteria. This document will be updated prior to handover of the Discovery Building to set out the post-commissioning plan for ongoing sterilisation of the water system.

5.5 Stockpile Management

A review of the locations of stockpiles and the grade of the material stored within stockpiles at Rothera was undertaken in April 2021. Stockpile locations are show in Figure 5-2 Known Stockpile Locations at Rothera.

[22] British Antarctic Survey (BAS), 2023. Water Quality Management Plan (v1.6)

Figure 5-2 Known Stockpile Locations at Rothera

There are several RMP and RUNSUR activities for the 2024 – 2025 and 2025 – 2026 Seasons that would require the use / relocation / deposition of stockpiled material at Rothera:

- Discovery Building Crane Winterisation Platform (RMP);
- Installing an external slab with fuel tank to the eastern yard of Discovery Building (RMP);
- Connecting Admirals and Discovery Building to the STP Drainage Installation (only if there is spare excavation material that needs to be stockpiled) (RMP)
- Managing Defects from 2023 - 2024 Season (RUNSUR);
- Defrost Frozen Chambers and Ducting – Scenario B (RUNSUR);
- Removal of Processed Aggregate (RUNSUR); and
- Processing Trench-Dug Material (RUNSUR).

Projects that will make use of stockpiled material have been identified within Section 4 of this IEE.

As all summer staff have now left Rothera, and it has been winterised to preparing from May to October, new information on the stockpiles on site will not be available until the beginning of the 2024 - 2025 Season due to snow cover.

Based on current understanding, there is 0-30 mm material stockpiled in Stockpiles 1-6 and 9-11. However, material in Stockpiles 9-11 is used for levelling storage areas and is therefore unavailable for use. Material stockpiled in Stockpile 5 is also unavailable because the area is used by BAS for plant and equipment storage. Material from Stockpile 5 will only be recoverable if an alternate location can be agreed with BAS to store their plant. Of the available 0-30 mm material, approximately 200 T is used per season for creating footpaths and gritting roads and should therefore be taken off the total considered available for use within projects.

There is 30-80 mm material in Stockpiles 9-11 which is largely recoverable. Additionally, there is 30-80 mm material also stockpiled within containers in the Wharf sub-structure, however it is onerous to recover, and therefore unavailable and unrecoverable. Material of various sizes is stockpiled in locations 1-4 and 9, this material is also largely recoverable.

It is also important to note the difference between useable stockpile locations, and those historic locations which have become unusable due to subsequent re-use.

Issues with material stockpiles throughout the 2023 - 2024 Season at Rothera revealed a clear need within BAS for a coordinated Stockpile Management Plan. A lack of data and reporting on stockpile volume, use by activity and availability on site, has put increased strain on the BAS Environment Office to resolve the issue in line with the procedures set out in the Section 6 permitting process. Additionally, this has caused project delays during the season. Following discussions internally and with construction partners BAM, BAS AIMP will be developing a Stockpile Management Plan for the 2024 - 2025 Season.

BAS have instructed BAM to conduct a stockpile survey as a priority at the beginning of the 2024 - 2025 Season to identify:

- Quantities and grading of material around Rothera;
- Origins of the material – which permit the material has been excavated under; and
- Under which project the already processed material is to be reserved for.

Once this Stockpile Management Plan has been compiled, it will be sent to the BAS Environment Office and FCDO for review and comment.

5.6 Crane Winterisation Platform

This RMP support activity comprises the removal and reinstallation of the existing crane winterisation platform, currently a series of wooden sleepers that sits in the North Yard. This platform will need to be removed ahead of the concrete slab being installed in the North Yard. Following this, material will be backfilled to reprofile the ground post-deconstruction. Approximately 20 m^3 of previous excavation material, taken from the fines stockpile, is to be spread across the Discovery Building's North Yard in order to finish reprofiling the area post-works. Following the completion of the North Yard, the crane platform will be reinstated at a location to be confirmed.

The activity is scheduled to occur at the end of the 2024–2025 Season and 2025–2026 Season.

5.7 Survey Control Point Installations

To facilitate the RENEW project and Hangar development, in the short term, and support future phases of AIMP, longer term, there are currently seven control points which provide topographic data across Rothera. For the upcoming seasons, it is proposed that seven additional control points are installed, with six positioned along the runway edge and one located behind the hangar building, adjacent to the Non-Directional Beacon (NDB). The works are planned to take place in January 2025 and are anticipated to last a maximum of two weeks.

Figure 5-3 illustrates existing control points (green and blue), the proposed locations of the new control points (red), as well as associated sight lines between points.

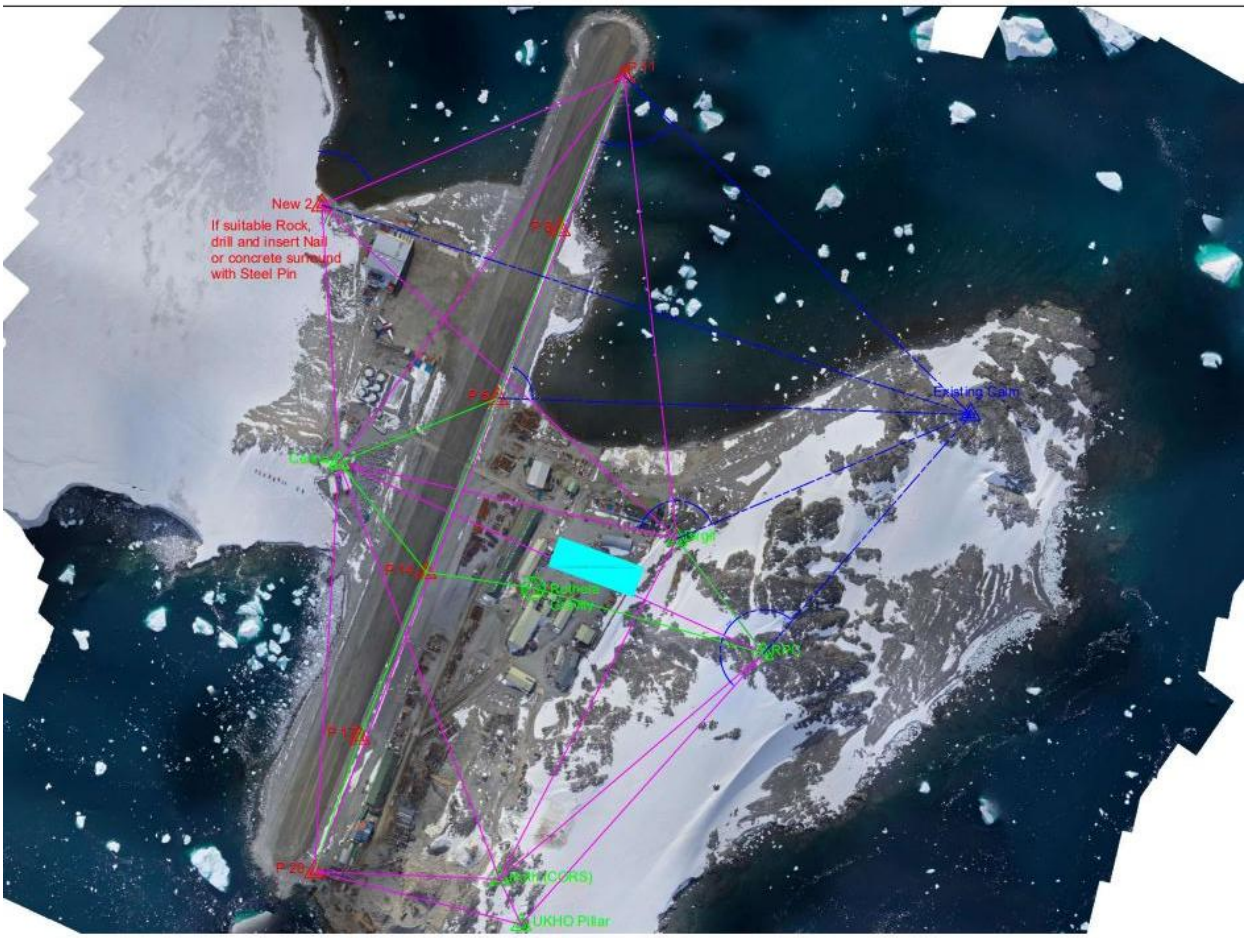

Figure 5-3 Existing and New Control Points at Rothera

For the six new control points installed along the eastern side of the runway, a single contractor will attend each of the sites, attaching a survey point nail (75mm in length) to existing manholes. No additional groundworks or intrusive works are required for the installation of these control points.

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For the single control point behind the hangar, two contractors will attend the site, and the following scenarios are proposed:

  - If there is a sight line from the NDB to the other control points is available, contractors will secure a survey point nail to the existing NDB, requiring no groundworks;
  - If a stable enough rock can be found with a sight line to the other control points, a hand drill would be used to drill a 30mm hole into the rock, before securing a 100mm x 20mm diameter rebar steel pin into the rock, to function as the control point; or
  - If the surrounding ground surface is loose, the two contractors will clear and level the area by hand using a pick and shovel, requiring approx. 30kg of rock to be moved, before depositing up to 30kg of concrete to secure the steel pin (as described in the previous bullet point) to the ground, to act as the control point (worst-case scenario).

- There would be a preference to take the first option as the best-case scenario to minimise ground disturbance at Rothera. Ground disturbance would only occur if the first option cannot be deployed. No heavy machinery or plant would be required for any scenario. All contractors would be briefed on the location of the nearby environmentally sensitive Ice Ramp, which is also an 'Operational Hazard Zone' (Figure 10-1 Environmental Constraints at Rothera) No groundworks or intrusive works are proposed at the existing control points.

5.8 Transporting Materials Across Rothera

In order to facilitate and support the construction activities for the upcoming 2024 – 2025 and 2025 – 2026 Seasons, there are several instances when construction material will need to be transported to the proposed construction site or out of the way of future activities, sometimes in close proximity to sensitive areas as is the case for the VLF relocation.

To improve the construction efficiency on site, transportation routes must be approved, clearly set out and adhered to, with all construction and relevant site personnel made aware of the agreed transportation routes and methodologies before the activity commences. Where transportation of materials is required for a specific project activity, available information on the preferred route, the vehicles and number of staff required and the amount and types of construction material to be transported is set out in the respective methodology in Section 4.

Examples of construction materials due to be transported across site for activities include:

- The new hut to accommodate the VLF equipment (Section 4.5):
  - The approved transportation route must be followed in order to avoid any impacts to the ASPA, a short distance to the north. Likewise, adhering to the requirement to detach the trailer from the skidoo for the descent to the beach and continue on foot, as the terrain is too dangerous for a skidoo, must be clearly set out and adhered to, to mitigate health and safety risks.

- To facilitate RMP activities:
- Transport of materials from the Wharf to the Discovery Building to complete the MEP installations and fit-out of the Building.
- Transport of waste from the decommissioning of 6 existing buildings and legacy waste to the Wharf for removal from Rothera.

6. ALTERNATIVES CONSIDERED

In accordance with the procedures set out in Annex I to the Environmental Protocol, alternatives to the proposed development should be considered. Alternatives to the proposed works could include consideration of different locations, different technologies (i.e., which technologies to use to construct or which technology to implement in operation), the use of pre-existing facilities and different timing of the activities. The "do nothing" scenario should also form a part of the alternatives assessment. The need for the proposed activities and methodologies set out in this IEE can be grouped under one of the following categories:

1. Safety and Risk to Human Health
2. Enabling Science Activities
3. Operational Efficiencies
4. Informing and De-risking Future Design

This alternatives assessment allows the identification of optimum working methodologies and/or design interactions that could either enhance the environmental benefits of the proposed activities or reduce or avoid any potentially significant negative impacts, whilst achieving the required objectives of the proposed development.

Due consideration of alternatives ensures that the IEE is not simply defending a single proposed approach for each activity, but instead provides the opportunity for an unbiased, proactive consideration of options.

For works at Rothera, the production and implementation of project specific SMPs ensures that sustainability is integrated into the design of the proposed activities. The production of SMPs at an early stage of the design process ensures that alternative designs can be implemented which reduce the environmental impacts of the proposed design, through minimising the footprint, material requirements and operational impacts (where relevant).

6.1 RENEW

The RENEW monitoring activities are required to inform decision-making for future renewable energy generation at Rothera. The building surveys are non-intrusive and therefore no alternatives that could reduce environmental impacts are available. The trenching of cables to supply the solar monitor located west of the runway with power may be intrusive depending on the final location of the monitor, but the benefits of undertaking this activity will be realised through reductions in future emissions once operational. The proposed activities align with the aims and objectives of the AIMP Sustainability Strategy as well as the Rothera Decarbonisation Strategy.

The options considered include:

Building Surveys:

Do Nothing: The do-nothing scenario would create risk in the future design of building mounted solar PV. Without knowing the condition of the roofs that may hold PV panels in future, there is a risk that excessive snow loading on top of the PV panels could cause the roof to collapse in the worst-case scenario. As a result, the do nothing scenario would prevent the aspirations to improve the sustainability of operations at Rothera and wider carbon emission reduction goals.

Alternatives: For the non-intrusive building surveys, alternative locations are not applicable as the surveys are required at specifically targeted buildings. Similarly, there are no alternative technologies available for this, as the surveys are to be undertaken by an appropriate qualified individual to observe the condition of the existing buildings.

Solar Monitoring:
Do Nothing: the do-nothing scenario would mean insufficient data on the expected solar generation from the area west of the runway. This would not affect the final design of ground mounted PV panels but would lead to a lack of knowledge on expected carbon emission reductions, and subsequently remove the ability to adapt the design were that information known.
Alternatives: The alternative scenarios have been listed in the methodology which include potential locations for the solar monitor that do not require cable trenching and therefore any groundworks. At the time of writing the ideal location of the solar monitor is not known as the final position of the ground mounted solar panels has not been decided. Therefore, a decision will be made within the season as to where to locate the monitor, and whether this requires trenching.

Therefore, the consideration of the "do nothing" scenario and alternatives has concluded that the proposed methodology is the optimal solution for the RENEW monitoring activities.

6.2 WHARF

The Wharf SI activities are required to inform the design and development of a potential new mooring point. Safety and operational resource concerns with the existing arrangement are the main driver for the mooring point relocation. At this stage of the project, a decision has not been made on the final solution for the mooring point, and these site investigations are considered necessary to inform this, notably whether or not to proceed with the next stage of ground investigations.

Do Nothing: The "do nothing" scenario would prevent the collection of sufficient information to inform the next phase of the project.
Alternatives: There are no viable alternatives that could reduce the environmental impacts of the site investigation, as the investigation will be carried out without any heavy machinery or plant, and will not disturb any ground.

Therefore, consideration of the "do nothing" scenario and alternatives has concluded that the proposed methodology is the optimal solution for the Wharf Site investigations.

6.3 RMP

Connecting Admirals and Discovery Buildings to the STP Drainage Installation
Do Nothing: The do-nothing approach would result in the Admirals and Discovery Building being isolated from the sewage treatment plant, failing to deliver the sitewide efficiencies and capabilities of the Discovery building and SWS as required by BAS.
Alternatives: There is no alternative to routing the SWS between Discovery and Admirals that would reduce the environmental impact of these activities.

BAM Fitters Workshop to IWHF SWS Re-Route
Do Nothing: The current layout of the SWS runs underneath the road between the BAM Fitters Workshop and IWHF. This activity will re-route the SWS adjacent to this road. The do-nothing approach would have little impact on the function of the SWS at Rothera, however if this route ever requires maintenance in future, the road will need to be excavated again causing further ground disturbance and greater environmental impact.
Alternatives: Alternatives include routing the SWS above ground along the Fitters Workshop's eastern elevation, eliminating the need to excavate and trench the SWS. This was discounted due to snow loading concerns. The solution proposed strikes a balance will allow for future maintenance, without structural damage concerns from snow loading.

Vikings House to Bentham Container Ducting
Do Nothing: The do-nothing approach would ultimately result in serious structural damage to the SWS in this area due to snow loading. This would require more environmentally costly works to remedy.

Alternatives: Alternatives include burying the SWS in this location rather than bringing the surrounding area up to level. This was discounted as a far more labour-intensive activity to excavate and re-trench the ducting than covering the ducts would be.

Bonner Laboratory to Gerritsz Laboratory SWS Rerouting

Do Nothing: The do-nothing approach would result in the Gerritsz Laboratory being isolated from the sitewide services and prevent the realisation of the efficiencies of the SWS.
Alternatives: Routing the SWS above ground along the Gerritsz eastern elevation was discussed and ultimately discounted, as this area is prone to excessive snowfall.

Bentham Communications Container to ARIES Dome Power Cable

Do Nothing: The “do nothing” scenario would prevent BAS from receiving image data from polar orbiting satellites to use for climate research and local weather forecasting. This would conflict with BAS’ scientific objectives.
Alternatives: The Bentham Container was deemed the best location for the ARIES dome to source power from given its proximity, providing the shorted route to connect, and resulting in minimal ground disturbance to supply power to the dome.

Discovery Earthing and External Fuel Tank Installation

Do Nothing: This activity is vital to ensure the Discovery Building is properly earthed and safe from an electrical standpoint. The fuel tank is needed to provide a refuelling point for BAS vehicles following the handover of the Discovery Building, replacing the refuelling tank located outside the current vehicles garage, which will be decommissioned as it is at the end of life.
Alternatives: There is no alternative to earthing the Discovery Building given the safety implications of the activity. The fuel tank is required to deliver the agreed the final design and capability delivery of the Discovery building as required by BAS.

Installing an external slab to the north yard of Discovery

Do Nothing: The do-nothing approach would result in the north yard of Discovery posing an operational and safety issue. The external slab will provide a level surface for vehicles and pedestrians to access, while preventing water and ice pools from forming on the surface.
Alternatives: There are no alternatives to the concrete slab installation that will provide the same level of safe and efficient operation.

Reprofiling road between Admirals to Runway Crossing

Do Nothing: The do-nothing approach may be employed if no safety concerns are present after an assessment has been made within the season.
Alternatives: Less environmentally impactful alternatives could include additional signage or improved comms on station. At the time of writing, it is not known what solution will be employed on site. The worst-case scenario environmentally has been included for assessment in this IEE.

Temporary South Access Road to Discovery Building

Do Nothing: The do-nothing approach would result in a lack of access to the Discovery Building while the works in the north yard are underway. This poses a huge risk to the handover of the Discovery Building, with the worst-case scenario pushing the project into another season, with the additional associated environmental impacts.
Alternatives: There is no viable alternative to access the Discovery Building other than its southern elevation, due to Fuch’s House to its west and the SWS to the east. As the internal fitout of the Discovery will be ongoing throughout the season, this activity is on the critical path and cannot wait for the north yard works to complete before proceeding.

Strip Out and Deconstruction of Existing Assets

Do Nothing: The do-nothing scenario in this instance is not recommended as unused buildings that are not maintained could become a safety risk for personnel at Rothera. The proposed deconstruction of buildings at Rothera presents an environmental improvement through the removal of unused infrastructure. This has particular importance for visual and setting impacts, along with supporting the overarching objective to minimise human footprints within the Antarctic.

Alternatives: The alternatives, such as location, are not applicable in this case as the existing building's locations are fixed at Rothera. The methodology for the deconstruction of these buildings has been designed to minimise the environmental impact as far as is reasonably practicable.

Removal and Containerisation of Waste, Removal of Containers from Rothera and Reprofiling of Ground

Do Nothing: The do-nothing approach would require leaving all the current containers and waste at Rothera, congesting the site, posing an environmental risk due to long-term storage of waste, and failing to comply with the Antarctic Treaty.

Alternatives: Waste may be removed from Rothera via a bulk cargo commercial vessel, or via a containerised cargo ship. If a container ship is chosen, waste will need to be cut into container-sized sections which will incur extra environmental cost. At the time of writing, it is not known which vessel will be chartered.

Crane Winterisation (RMP)

Do Nothing: This activity is essential to allow for the installation of the external concrete slab in the North Yard.

Alternatives: There is no alternative to this activity to allow for the installation of the concrete slab.

6.4 RUNSUR

The RUNSUR activities included within this IEE are required to manage defects that have arisen since the resurfacing works and to maintain full functionality of runway services. Where available, alternative methodologies have been set out and assessed within this IEE to ensure that the potential environmental impacts of the worst-case scenario have been assessed. It must be noted that the worst-case 'Scenario B' shall only be implemented in the case of an unsuccessful Scenario A. Beyond the two scenarios presented, no viable alternatives that could reduce environmental impacts are available.

Managing Defects from 2023-2024 Season

Do Nothing: At the time of writing the defects of the runway are not known and will be investigated upon arriving at site in the start of the 24/25 season. There may be no defects to manage in which case no course of action will be taken. Otherwise, if defects are found, the risk of not managing these would be a non-compliant runway and a huge risk to safety, as well as general operations at Rothera.

Alternatives: Should defects such as potholes or subsidence be found on the runway, no alternatives that would bring the runway within compliance and mitigate the risks to aircraft safety are available.

Defrosting and Waterproofing Frozen Chambers

Do Nothing: The do-nothing approach would compromise the future sitewide services of Rothera, as future cabling for the Renewables and Hangar upgrade projects is designed to run through these ducts. Eventually, the do-nothing approach would cause structural damage to the ducts and chambers as the chambers are not currently waterproofed, allowing more flooding and freezing.

Alternatives: Initially, Scenario B (excavating all chambers and ducting to replace frozen ducts) was set out as the methodology for this activity. Further investigations to find a less environmentally and operationally costly process were discussed over summer 2024 and ultimately Scenario A, a process to jet hot water through the ducts, took place in July 2024. This trial demonstrated that the ducts may not need excavation and replacement to defrost them. While the jet water trial showed promising results, it is unknown if it will work until it is trialled on site, therefore the allowance for Scenario B has been included in this IEE.

Removal of Processed Aggregate

Do Nothing: The do-nothing approach would not allow for the defrosting of runway chambers P01 and P02 in the 24/25 season which the aggregate currently sits atop.

Alternatives: The aggregate is proposed to move to the stockpile on the western side of the runway for future runway maintenance. This has been deemed as the best option for future runway maintenance stockpiles as it is away from the central construction activities around the Discovery Building, reducing the risk of stockpiles being used for other construction activities.

Processing Trench Dug Material

Do Nothing: The do-nothing approach would prevent the trench dug material from being used for future runway maintenance.

Alternatives: There is no alternative method to process the trench dug material. As with the removal of processed aggregate, the location for this material has been deemed the best option for future runway maintenance stockpiles.

Therefore, the consideration of the “do nothing” scenario and alternatives have concluded that the proposed methodology is the optimal solution for managing runway surface defects as part of the RUNSUR scope of works.

6.5 VLF Equipment Relocation

The proposed VLF equipment relocation is required as the OBH building that is currently used to house the VLF equipment is scheduled to be deconstructed as part of the RMP activities. No suitable locations within existing buildings are viable due to the need to avoid EMI associated with the new Discovery Building. Therefore, no viable alternatives that could reduce environmental impacts are available.

The options considered include:

Do Nothing: The “do nothing” scenario would result in a cessation of the long-term monitoring of weather in the upper atmosphere. This would conflict with BAS’ scientific objectives.

Alternatives:

- Alternative locations were investigated on Rothera that would provide the same standard of monitoring without having to expand beyond the main footprint of Rothera. The location chosen for the new VLF hut avoids EMI which is key to the VLF monitoring, while also being in proximity to a power supply at the East Beach Hut.
- The equipment to be relocated cannot be housed within the existing East Beach Hut for lack of room, so the creation of a new structure is required.
- This new structure will sit on gabion basket foundations removing the need for more intrusive concrete foundations and is designed to be assembled and disassembled on site by hand, allowing the site to return to its natural state if the VLF hut is to be removed or relocated in future.
- The hut is constructed of less carbon-intensive treated timber frame panels.
- Transporting the VLF hut materials to site will occur towards the start of the season while snow cover remains high, allowing the team to use skidoos rather than heavier plant that would be necessary under less snowy conditions. The possibility of transporting materials via a small boat from the Wharf was also discussed, however this was discounted due to past experience constructing the East Beach Hut and the safety risks involved.

Therefore, the consideration of the "do nothing" scenario and alternatives have concluded that the proposed VLF Equipment relocation is the optimal solution for the housing of the VLF equipment.

6.6 Support Activities

6.6.1 Personnel

Water usage associated with the number of personnel at Rothera fluctuates throughout the year due to varying numbers present; between March to September average potable water use is 70 m^3 per month and average saltwater use is 30 m^3 per month (21 personnel), whereas between October to December average potable water use is 200 m^3 per month and average saltwater use is approximately 90 m^3 per month (70 - 90 personnel average).

The options considered include:

- Do Nothing: The "do nothing" scenario would result in the production of increased volumes of waste being produced that the STP may be unable to process, therefore, there is an increased risk for a potential environmental impact resulting from the discharge of untreated sewage.
- Alternatives: The alternatives include the appropriate management of personnel numbers on site and to ensure that those present at Rothera are required and are present for the appropriate duration during the 2024 - 2025 and 2025 – 2026 Seasons.

Therefore, the "do nothing" scenario and the alternatives conclude that appropriate management of the number of personnel, in relation to the existing infrastructure, undertaken to avoid an environmental impact, is the optimal solution.

6.6.2 Water

Low Temperature Hot Water Flushing

Do-Nothing: The "do-nothing" scenario comprises the LTHW systems not being flushed. This poses a risk to the efficiency of the system, increased energy and possibly boiler failure in the worst-case scenario.

Alternatives:

- Initially, it was proposed that the entire LTHW network would need flushing with commercial cleaning solution, which was to be flushed into the sea. This would have resulted in 16,000L of contaminated water entering the Antarctic sea untreated.
- To prevent this water being discharged to sea, the option to store this contaminated water and ship it back to the UK was also discussed, however this would require an equal volume of antifreeze to prevent the solution from freezing, creating more contaminant.
- Following extensive discussions with the Environment Office and design teams, a compromise to flush only part of the system was reached, with BAS accepting the risk of lower efficiencies by not flushing the entire LTHW network. This solution still creates 4,000L of contaminated water, but this can be stored inside and shipped back to the UK rather than being discharged in Antarctica.

The "do-nothing" scenario would therefore be the optimal solution as it would create no extra contaminated water or incur any carbon cost to ship water back to the UK. However this would affect the long term efficiency of the LTHW system, potentially causing more maintenance problems in future.

Potable Water Sterilisation

Do-Nothing: The "do-nothing" scenario would pose a serious risk to human health from legionella bacteria.

Alternatives:

- This activity is considered unavoidable due to the risk to human health if it is not conducted.
- Initially, the hydrogen peroxide solution was proposed to be flushed directly into the sea after cleaning.
- Following extensive discussions with the Environment Office and design teams, a solution that avoids flushing the peroxide solution into the sea was reached. The solution will be held in storage and tested for hydrogen peroxide until it has decomposed into water and oxygen, at which point the solution will be discharged to sea via the STP.

6.6.3 Resourcing

For all scoped activities, the programme of works is carefully planned based on the limited availability of resources and duration of the construction season at Rothera. Therefore, resource usage is optimised and no further mitigation to reduce the overlap in activities exists, due to the constrained nature of the construction season.

Similarly, material selection is carefully reviewed to minimise the material required to be transported to Rothera via the SDA which has limited capacity. Re-use of existing materials is undertaken as standard which supports BAS' sustainability objectives, and consequently the material requirement for the proposed activities within this IEE is optimised through the need to minimise material transfer to site.

7. OPERATIONAL PROCEDURES

7.1 Fuel Management and Spill Responses

Fuel oil is used to power research stations, ships, and aircraft. Major oil spills are rare in the Antarctic, but as human presence in the region increases, so does the risk of a spill. Because of the potentially disastrous effects of oil spills on the pristine Antarctic environment, the Antarctic Treaty's Protocol on Environmental Protection requires all Treaty nations to prepare contingency plans to deal quickly and effectively with environmental emergencies resulting from their Antarctic operations.

To prevent oil spills, bulk fuel at BAS research stations is stored in tanks with secondary containment. BAS now use a blend of MGO and Aviation Carrier Turbine (AVCAT) fuel as the standard fuel at Rothera. BAS carries out oil spill response training for key personnel and winterers as well as spill response exercises in Antarctica twice a year at each wintering station.

7.2 Fuel Use, Fuel Storage and Refuelling

The following oil storage facilities are located at Rothera: six main bulk fuel tanks, fuel drum depots, two day holding tanks, a boiler fuel tank, and several other small bulk fuel tanks.

All fuel required at Rothera will be stored by BAS in one of the above storage facilities, and oil spill equipment such as the sorbents and putty, as specified within the Oil Spill Contingency Plan (OSCP) will be located adjacent and accompany the fuel bowser at all times. Additionally, all mobile plant is required to carry oil spill kits at all times. Spill kits would comprise absorbent materials such as absorbent nappies, PPE, products to seal leaking containers, products to seal drains and hazardous waste bags. The refuelling of plant and equipment will be carried out by nominated refuellers and compliant with the BAM refuelling procedures. The Standard Operation Procedure (SOP) for refuelling at Rothera applies.

Rothera has provision for the bulk storage of 720,000 litres of MGO and 690,000 litres of Aviation Turbine fuel (AVTUR) in drums. A further provision of 123,000-205,000 litres of Aviation Carrier Turbine fuel (AVCAT) is stored in bulk tanks at Rothera (600-1,000 205 litre drums). All the long-term storage tanks are made from steel and are contained within a bund, ensuring containment should a spill or leak occur. The AVCAT and AVTUR dispenser is located at the south end of the aircraft apron and the MGO pump is located at the south-east corner of the tank containment area. The bulk fuel storage at Rothera is outlined in more detail in the OSCP.

Alternative fuels are being considered for use at Rothera, at the time of writing trials have been undertaken but a viable solution is not yet proposed and approved for use. When/if such alternative fuels are introduced at Rothera, the protocols in place for use, storage, management, refuelling and spill responses shall be reviewed to ensure these remain fit for purpose.

7.3 Rothera Oil Spill Contingency Plan

The purpose of the Rothera OSCP, Appendix 2, is to describe the procedures that will be used by BAS/BAM to enable a timely, effective, and coordinated response effort in the event of an oil spill at Rothera. Any spills will be reported to the Rothera Station Leader and to the BAS Environment Office at the time of occurrence.

Oil spill incidents within BAS are classified in to three tiers listed below. This classification into tiers allows the appropriate response to each spill incident to be undertaken immediately, the Tiers are as follows:

- Tier 1: The incident can be dealt with by one or two station personnel or a small subset of the station response team using local response equipment;
- Tier 2: The incident requires the full response capability of Rothera and assistance from BAS Cambridge; and

- Tier 3: These incidents are those that exceed the response capability of Rothera and BAS Cambridge, and therefore further assistance is required.

BAM staff are responsible for dealing with any Tier 1 spill they have caused and must report them to the Station Leader as soon as possible to ensure an appropriate response is being followed and for inclusion on the BAS Maximo Incident Reporting System. The Station Leader has overall responsibility for Tier 2 or Tier 3 incidents at Rothera. BAS will be responsible for and respond to any land-based spills into water, or spills from the SDA. All site operatives will be briefed on the OSCP prior to the works commencing.

7.4 Plant Management

The BAM Plant Management Plan (PMP) will be adhered to for the proposed works and will define the minimum requirements for the management of all plant and equipment used at Rothera. It describes the procedure for safe operation, maintenance, inspections, and emergency repairs of plant at Rothera.

The BAM PMP and PEP will also describe the personnel requirements including, but not limited to, required certification for safe operations of the equipment. Furthermore, the process for plant selection, procurements, and the overall plant strategy will also be included in the PMP.

The BAM PMP is a live document and subject to change during the course of the AIMP Project following review.

7.5 Waste Management

The construction waste management at Rothera is the responsibility of BAM. As BAM are required to take all reasonable steps to keep waste safe and secure so that it does not enter the pristine Antarctic environment where it would pollute the environment and has the potential to injure or damage the native flora or fauna in the terrestrial or marine environment.

BAM are required to:

- Fulfil the legal requirement to apply the waste hierarchy;
- Ensure safe and correct packing and containment of waste, this is of particular importance while waste is in transit;
- Undertake checks that waste contractors are appropriately registered with the Environment Agency (EA);
- Describe the waste being transported appropriately on a Duty of Care transfer note so that the waste carrier can avoid committing an offence under the regulations; and
- Liaise with BAS Environment Office over the importation of waste to the UK via transit ports and ensure that the appropriate approvals are sought.

The waste hierarchy will be applied when reviewing waste management options to determine the environmental impacts of the hierarchy:

- Prevention;
- Preparing for re-use;
- Recycling;
- Other recovery; and
- Disposal.

The measures outlined in Table 7-1 will be employed to reduce and reuse waste on-site.

Table 7-1 Measures to be Implemented to Reduce and Reuse Waste On-Site

Reduction Measures	Reuse Measures
General	
• Packaging to be discussed with suppliers and reduced as much as possible. • All operatives to receive training on the agreed reduction measures. • Accurate measurement and minimal wastage will be allowed when ordering materials. • Materials will be stored and transported correctly so as to avoid damage. • Materials are to be kept off the ground by the use of pallets or timber pieces.	• All unused excavated material, except any hazardous waste, will be added to existing stockpiles for use in future projects or general station maintenance. • All useful surplus construction materials to be offered to the Research Station Manager for re-use within Rothera.
Excavated Soil and Stone	
N/A	• Excavated soil and stone to be redistributed at Rothera
Timber	
N/A	• All construction waste materials to be offered to the Research Station Manager for re-use within Rothera.
Concrete and Hardcore	
• Concrete ducting to be packed and transported with care to avoid the potential to be damaged.	• Waste concrete to be crushed and added to existing stockpiles for use in future projects or general station maintenance.

In addition to reuse measures, recovery measures are also implemented at Rothera such as waste timber to fuel the incinerator.

All waste that cannot be reused at Rothera will be returned to the UK for recycling or disposal at a licenced waste management facility. A commercial vessel will remove construction waste in March 2026. Consignments will be packed and labelled in accordance with international shipping regulations. Waste will be disposed of in the UK by licenced waste contractors meeting the requirements of the Waste (England and Wales) (Amendment) Regulations, 2014, the Duty of Care Regulations, 1991, and the Hazardous Waste Regulations, 2005. All waste will be packaged and consigned in accordance with BAS's standard waste management procedures set out in the BAS Waste Management Handbook.

The estimated types and quantities of waste that will be produced on-site, further details are included in Appendix 1 which will be updated, and a final copy will be issued prior to mobilisation for the proposed works.

The SWMPs for RMP and RUNSUR are considered to remain accurate for the current scope of works. Any additional waste produced as a result of the previously assessed activities with changed scopes from the RUNSUR and RMP activities mentioned in this IEE will be logged by an environmental engineer to track both the amount and type of waste produced on site on a monthly basis. This information, along with total waste produced annually, will be fed back to BAS, and logged in the Post-Season Environmental Report.

The incinerator runs frequently to burn waste, such as food waste, sewage sludge and biosecurity risks. BAM will provide BAS with waste wood to recover this material as fuel for the incinerator. A full record will be kept, and internal waste transfer notes produced if required. Waste sent for incineration is carefully managed and agreed with BAS site personnel who operate the incinerator.

All domestic waste generated during the construction period will be managed by BAS as per the standard Rothera waste management procedures. All staff will comply with the waste storage and segregation requirements as directed by the Rothera Station Leader.

7.6 Biosecurity

It is essential that all necessary precautions are taken to prevent the introduction of non-native species to Rothera from other locations. BAS have Biosecurity Regulations which set out clear instructions and procedures for BAS personnel and external collaborators detailing how to reduce the risk of non-native species introduction and how to respond should an introduction inadvertently occur.

The AIMP has involved an increased input of cargo to Rothera over an extended timescale due to required construction materials. This intensification of import activity therefore has the potential to increase the risk of non-native species introductions into the local environment.

An AIMP 2024-2025 & 2025-2026 Projects-Specific Biosecurity Plan, Appendix 3, has been prepared to provide guidance to BAM personnel on the measures to be taken when moving plant, materials, or personnel to Rothera. The plan has been developed in accordance with the BAS Biosecurity Regulations (2023) and the CEP Non-Native Species (NNS) Manual (2019). All personnel will be briefed on the plan and will be required to read and understand its content prior to deployment.

Biosecurity measures include actions that require pre-departure checks on personal items and cargo, and pre and post disembarkation of cargo and personnel on arrival at Rothera. Inspections would be undertaken by trained personnel under the direction of the BAM Environmental Manager. Visits to suppliers are also carried out to ensure that premises used for manufacture, storage and packing, address biosecurity issues. Fumigation and biosecurity inspections are carried out when materials are consolidated into containers for shipment. All cargo would be inspected before loading onto the vessel.

Upon arrival at Rothera, all cargo would be re-inspected either on board the vessel or after being unloaded. All inspections will be recorded, and any incursions reported to the BAS Environment Office within 24 hours.

7.7 Health and Safety of Staff

The health and safety of staff at Rothera is considered to be covered by standard operational procedures that are in place for all operations at BAS. Specific risk assessments are carried out for all construction activities to ensure the safe completion of proposed activities. For example, construction personnel will wear appropriate personal protective equipment (PPE) such as ear protection, hi-vis clothing, glasses, safety boots, and hard hats, whilst in proximity to large machinery, earthworks, and hazardous equipment e.g. saws. Risk assessments are briefed to health and safety staff and the operations team present at Rothera prior to commencement of an activity, which aids the safety of the way in which construction and BAS estates activities are undertaken simultaneously such as air operations, vehicle movements, working near water, and working at height. There are also health and safety inspections and audits throughout the season. Monitoring is also in place which can indicate health and safety risks to be incorporated as part of a dynamic risk assessment process. Although humans are considered a receptor, this is not assessed specifically within this IEE.

8. PROGRAMME OF WORKS

Figure 8-1 Programme of works for AIMP 2024 – 2025 and 2025 – 2026 Seasons

		2024		2025												2026			
PROJECT	Activity Description	N	D	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A
FAC	CBR Testing																		
FAC	Friction Testing																		
HANGAR	SI Works																		
RMP	Finishing works to prepare the Discovery Building for Handover																		
RMP	Installing an external slab with fuel tank to the eastern yard of Discovery Building																		
RMP	SWS Structural Repairs and Remedial Work																		
RUNSUR	Installation of Non-Engineered Slipways adjacent to runway																		
WHARF	Installing Mooring Weights at the Wharf																		
RENEW	Visual / non-intrusive condition surveys of existing structures (including use of MEWP)																		
RENEW	Cabling for Solar Monitor West of Runway																		
RMP	Strip Out of Existing Assets																		
RMP	Deconstruction of Existing Assets																		
RMP	Removal and Containerisation of Waste, Removal of Containers from Rothera, and Reprofiling of Ground																		
RUNSUR	Removal of Processed Aggregate																		
RUNSUR	Processing Trench-Dug Material																		
RMP	SWS Excavation Activities: BAM Fitters Workshop to WHF SWS Re-Route																		
RMP	SWS Excavation Activities: Vikings House to Bentham Container Ducting																		
RMP	SWS Excavation Activities: Bonner Laboratory to Gerritsz Laboratory SWS Rerouting																		
RMP	SWS Excavation Activities: Bentham Communications Container to ARIES Dome Power Cable																		
RMP	SWS Excavation Activities: Connecting Admirals and Discovery Building to the STP Drainage Installation																		
RMP	SWS Excavation Activities: Excavation and Backfilling beneath Discovery North Yard Concrete Slab																		
RMP	Installing an external slab to the north yard of Discovery																		
RMP	Reprofiling road between Admirals to Runway Crossing																		
RMP	Temporary South Access Road to Discovery Building																		
RMP	Crane Winterisation																		
RMP, RUNSUR	Frozen Chamber & Duct Remedial Scenario A: Water jetting of frozen ducting																		
RMP, RUNSUR	Frozen Chamber & Duct Remedial Scenario B: Excavation of flooded and / or frozen ducting and chambers																		
RMP, RUNSUR	Frozen Chamber & Duct Waterproofing sealing of chambers																		
RUNSUR	Managing runway defects, including scarification																		
VLF	VLF Equipment Relocation																		
WHARF	Hand-Digging and GPR Survey for East Mooring Point																		
SUPPORT	Survey Control Point Installations																		
SUPPORT	Flushing/Cleaning of LTHW Systems																		
SUPPORT	Sterilisation of Potable Water																		
SUPPORT	Shipping Cargo to and from Rothera																		
SUPPORT	Storage of Cargo at Rothera																		
SUPPORT	Transport of Personnel to and from Rothera																		
SUPPORT	Provision of Accommodation, Power, Logistical and Domestic Services																		
SUPPORT	Site Set-Up and Presence of Personnel																		
SUPPORT	Fuel Management and Refuelling																		
SUPPORT	Vehicle, Plant and Equipment Operation																		

Known Period of Works	Previously Assessed Activities
Assumed Period of Works	Previously Assessed Activities with Scope Changes
No Work - Between Seasons	New Activities

9. DESCRIPTION OF SITE

9.1 Location

Rothera is located on the south-eastern shore of Adelaide Island on the Antarctic Peninsula (Lat. 67°35'8" S, Long. 68°7'59" W). Adelaide Island is 140 km long, mountainous, and heavily glaciated, with its highest peak at 2,565 m. Rothera is mainly situated over an area of raised beaches which form a topographic "saddle" between Rothera, a large rock promontory to the east, and Reptile Ridge, a jagged outcrop of rock to the west. Rothera is shown in Figure 9-1.

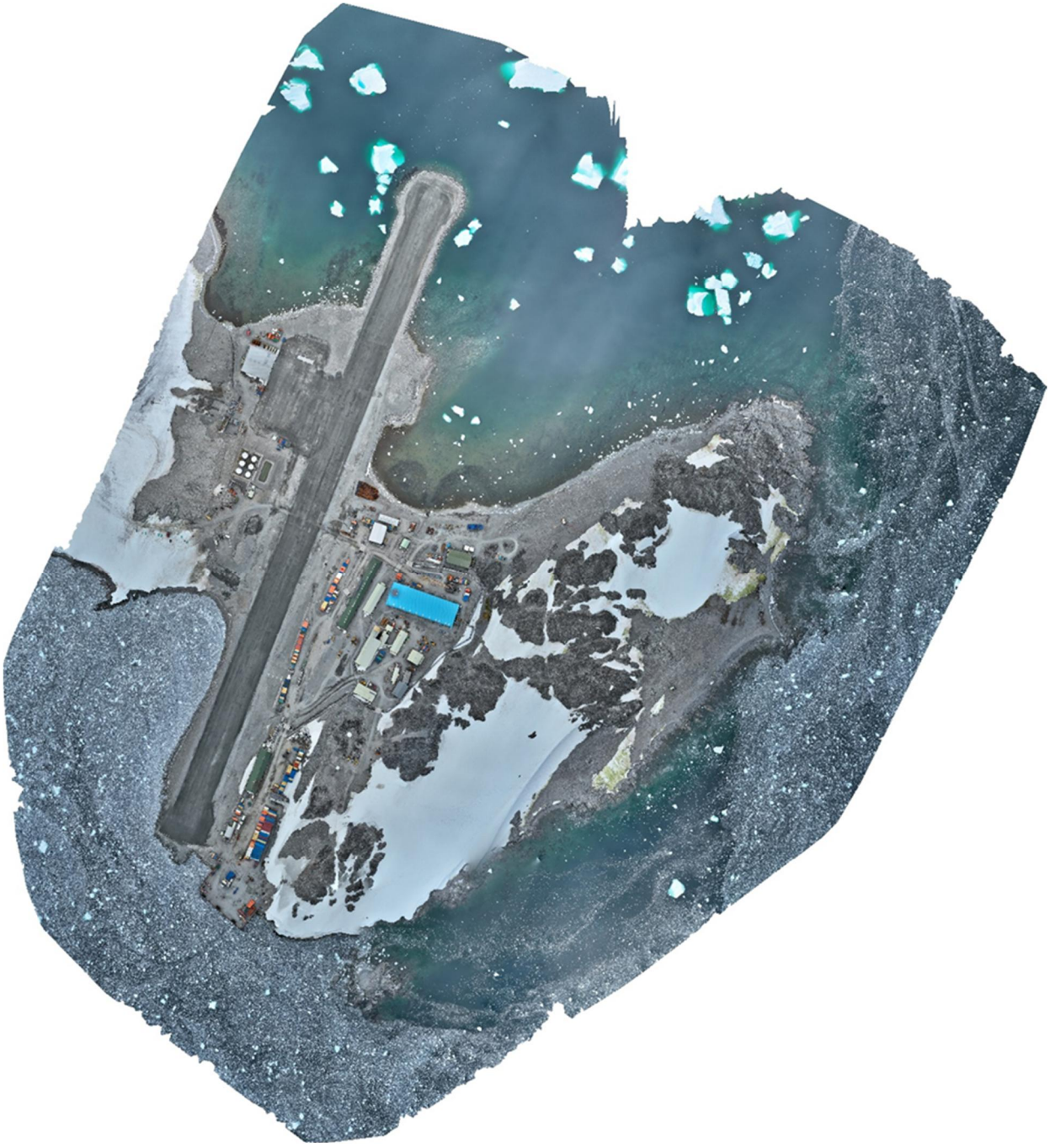

Figure 9-1 Drone Image of Rothera in 2024, Jonathan Witherstone – BAS

9.2 History of Site

Rothera has been used operationally on a continuous basis since 25 October 1975. The extent of human modification of the landscape at Rothera is described in Table 9-1 and is visible in Figure 9-2 and Figure 9-3. Rothera was initially planned and constructed in phases which meant that infrastructure development was constructed as operational requirements and demands changed. The eastern side of Rothera is largely free of buildings; however, several antennae have been erected here.

Table 9-1 Chronology of Construction on Rothera

Order	Phase or infrastructure	Notes
1	Phase I	A small accommodation hut was erected on 01 February 1976.
2	Phase II	Phase II was built in 1976/77, which included the main accommodation block, powerhouse and tractor shed. An old storage shed from Adelaide (Station T) was erected close to Phase I and known as the Bingham building after Surgeon Commander EW Bingham, Leader of BAS 1945-47.
3	Phase III	Phase III was erected 1978/79 and included scientific offices and a travel store and cold room. In 2001 the travel store was named Fuchs House after Sir Vivian Fuchs, Director of BAS 1958-73. Further building work has been undertaken when required.
4	Phase IV	Phase IV, begun November 1985 and completed in the 1986/87 season was an extension to Phase II. In 2001 it was named Bransfield House (after BAS ship RRS *Bransfield*).
5	Runway and aircraft infrastructure	A Wharf and gravel runway (with bulk fuel tanks and aircraft hangar) became operational in the 1991/92 season. Substantial rock blasting occurred, including the removal of 'Flagstaff Hill'. The Wharf was named Biscoe Wharf after the BAS ship RRS *John Biscoe*. A new storage hut, now used primarily for waste management activities, was also constructed in 1991/92.
6	Boat shed, accommodation and generator shed	Under the next phase of development, a boatshed was completed in 1994/95, a transit accommodation block in 1996/97 (named Giants House in 2001 after the Rothera sledge dog team "Giants"), and a new generator shed.
7	Bonner Laboratory	The Bonner Laboratory became operational in 1997, housing biological research facilities when Signy (Station H), was reduced to summer only operations. It was named after W N Bonner, biologist 1953-86 and Deputy Director of BAS 1986-88.
8	Accommodation and air operations control tower	A new accommodation building was erected during the 1999/00 and 2000/01 Seasons. It was named Admirals House after the Rothera dog team "Admirals". Also, in 1999/00 an air operations control tower was added to the north end of Bransfield House.
9	Replacement Bonner Laboratory and STP	The Bonner Laboratory was destroyed by fire on 29 September 2001 but rebuilt in the 2002 - 2003 Season, when a STP was also erected.
10	NBH	A new living block, including canteen, library, and recreational facilities, was completed in 2007/08 and named NBH. The original Bransfield House then became known as 'OBH'.
11	Dirck Gerritsz Laboratory	The Dirck Gerritsz Laboratory was opened on 27 January 2013 by Leo le Duc on behalf of the Ministry of Education, Culture and Science of the Netherlands. The laboratory is a collaboration between the British Antarctic Survey and the Netherlands Organisation for Scientific Research (I) and hosts four research projects.
12	Rothera Wharf	The redevelopment of Rothera Wharf commenced in the 2018-2019 season and was completed in the 2020-2021 Season.
13	Discovery Building	The construction of the new Discovery Building is currently ongoing, anticipated to be completed in April 2025.

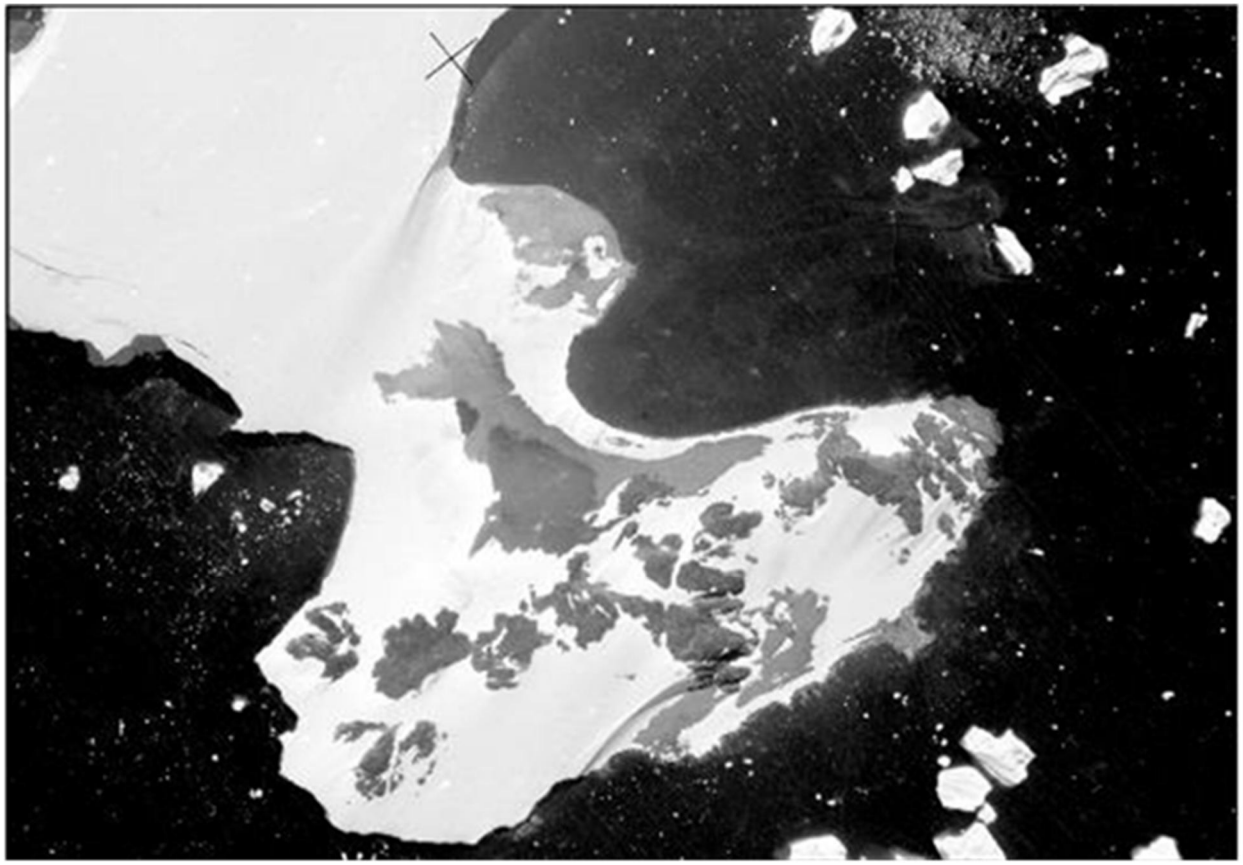

Figure 9-2 Aerial Image of Rothera in 1957, (Source: British Antarctic Survey)

Figure 9-3 Aerial Image of Rothera in 2013, (Source: British Antarctic Survey).

9.3 Current Use of Site

9.3.1 Domestic

Rothera can currently support a maximum of 163 bed spaces which comprises both science and operational support personnel and includes the 32 beds in the temporary accommodation at Vikings installed for use by the construction teams during the austral summer.

9.3.2 Science

Rothera is a research centre that supports a wide range of collaborative science programmes between BAS and other research institutes, for example the Gerritsz Laboratory is staffed by scientists from the Netherlands polar research programme.

The scientific research conducted at Rothera spans a wide range of disciplines, including space weather, terrestrial biology, marine biology, oceanography, meteorology, atmospheric chemistry, and ozone monitoring. The research at Rothera is led by three main BAS teams:

- Atmosphere, Ice and Climate (AIC);
- Space Weather and Atmosphere (SWA); and
- Biodiversity, Evolution and Adaptation (BEA).

Atmosphere, Ice and Climate

Meteorological data has been collected at Rothera since 1976, providing 48 years of continuous climatological data. These continuous data sets have provided the backbone of the important climate statistics from the Antarctic Peninsula over the last four decades. Weather balloons are launched at over 400 locations around the world at the same time each day. These data points are used in real-time by weather forecasters to get a global snapshot of the atmosphere. Climate scientists are also interested in the long-term records of temperatures at different heights in the atmosphere. At Rothera weather balloons are launched five times a week from only 18 launch sites, so each site is crucial.

Precipitation quantities are difficult to accurately measure in windy and snowy conditions, as are present at Rothera. An array of precipitation sensors operates side-by-side to provide the most accurate level of precipitation possible and also provides information on which types of sensors work best in differing conditions.

There is a tide gauge installed at the Wharf, which is calibrated once a week by conducting a tide dipping. This tide gauge forms part of the Global Sea Level Observing System (GSLOS).

It is vital that scientists continue to monitor the levels of ozone in the atmosphere so that they can understand the current state of the Antarctic ozone hole. At Rothera this is achieved using a Systeme d'Analyse par Observations Zénithales (SAOZ) instrument. SAOZ measures scattered sunlight in a way which allows scientists to determine how much ozone the light has passed through.

Space Weather and Atmosphere

Physical scientists use medium frequency radar and meteor radar to study wind and temperature in the upper atmosphere above Antarctica. A low-power magnetometer at Rothera – one of a chain of instruments that BAS has installed across Antarctica – records variations in the Earth's magnetic field.

Bonner Laboratory and Biodiversity, Evolution and Adaptation

The Bonner Laboratory supports station-focused science projects predominantly in the areas of marine biology, oceanography, and terrestrial biology. The BEA team aims to understand how past, present, and future environmental change has and will affect polar biodiversity both on land and in the ocean, and how life adapts to extreme polar conditions. Their research outcomes will provide deep insight into the impact of environmental change on the natural world, make a strong contribution to future conservation measures and generate new and innovative areas of research that have potential societal benefits.

9.4 Operations

9.4.1 Air Operations

To support science and logistics in Antarctica, BAS operate a fleet of five aircraft specially adapted for flying in the extreme Antarctic climate. The BAS aircraft consist of four De Havilland Canada Twin Otters, and one De Havilland Canada Dash-7. These aircraft are equipped with modifications to allow them to carry out airborne science surveys. Between them they undertake a wide variety of transport and science missions.

Due to the 876 m gravel runway at Rothera, the Dash-7 is able to undertake regular shuttle-flights to and from South Atlantic gateways and is able to carry fuel and provisions to the deep field site at Sky Blu which supports a blue ice runway. The Twin Otter aircraft carries much smaller payloads but is more versatile being able to land on wheels or skis and regularly transport scientists to remote deep field study sites within Antarctica.

9.4.2 Vehicle Operations

Vehicles play a key role in moving people and equipment around Rothera. A team of vehicle mechanics and plant operators undertake maintenance of vehicles. The day-to-day coordination of vehicle use is arranged between BAM, the Facilities Engineer, and Rothera's management team. The current vehicle fleet at Rothera includes skidoos, tractors, trailers, forklift and bucket loaders, Sno-Cat, dozers, cranes, gators, all-terrain vehicles, snowblower, fire truck, diggers, tankers, and excavators.

9.4.3 Boating Operations

Boating operations are a vital part of science and operations activities at Rothera. There are currently five boats within the Rothera fleet along with the SDA polar research vessel. Sea Rover and Terra Nova are primarily used as science platforms, in particular for deployment of Conductivity, Temperature and Depth (CTD) sensors. The three Humber Destroyers are used for diving and SAR cover for air operations as required. The SDA has a tender which can be deployed for movement or larger cargo items to locations around Rothera.

10. DESCRIPTION OF ENVIRONMENT

This section provides a description of the relevant parts of the baseline environment at Rothera. Rothera is largely ice-free which is relatively rare for Antarctic sites; recent estimates suggest that ice-free ground may comprise as little as 0.18% of Antarctica[23].

Figure 10-1 presents the relevant environmental constrains at Rothera, which have been used to inform the risk rating and impact assessment presented within this IEE. The environmental constraints map of Rothera identifies the existing buildings, surface water features, vegetation, the ice ramp, and operational hazard zones alongside the ASPA, heritage assets and communications instruments. The key environmental receptors which are most likely to be impacted by the proposed works are terrestrial flora and fauna (e.g., the moss patch[24], nesting skuas and biosecurity risks) and local glaciology.

[23] Burton-Johnson, A., Black, M., Fretwell, P. and Kaluza-Gilbert, J.. 2016. An automated methodology for differentiating rock from snow, clouds, and sea in Antarctica from Landsat 8 imagery: A new rock outcrop map and area estimation for the entire Antarctic continent. The Cryosphere, 10. 1665-1677.
[24] The moss patch has been erroneously referred to as moss “bank” in historic documents, however, it will be given the correct name in future EIAs.

Figure 10-1 Environmental Constraints at Rothera

10.1 Ecology

Levels of biodiversity at Rothera are not high compared to other equivalent areas. For example, the nearby islands in Ryder Bay have much higher levels of biodiversity. However, Rothera does contain some examples of Antarctic fellfield environments, which are reasonably rare in the wider area[25]. In contrast, the near shore marine environment is considerably more species diverse and the subject of most biological research in the area.

10.1.1 Terrestrial Flora

Overview of Plant Diversity and Distribution on Rothera

A variety of species are present at Rothera including vascular plants, mosses, lichens, and algae[26]. Mosses have a very low coverage across the entire area, as is expected with the prevailing rocky substrata; they were almost absent in the ASPA and occurred predominantly in the non-ASPA area associated with the occurrence of loose sediments, with the dominant species being *Sanioneonineat*a. Vegetation mapping, Figure 10-2, indicated that the highest values were on the top of rock bluffs where there was an abundant growth of lichens.

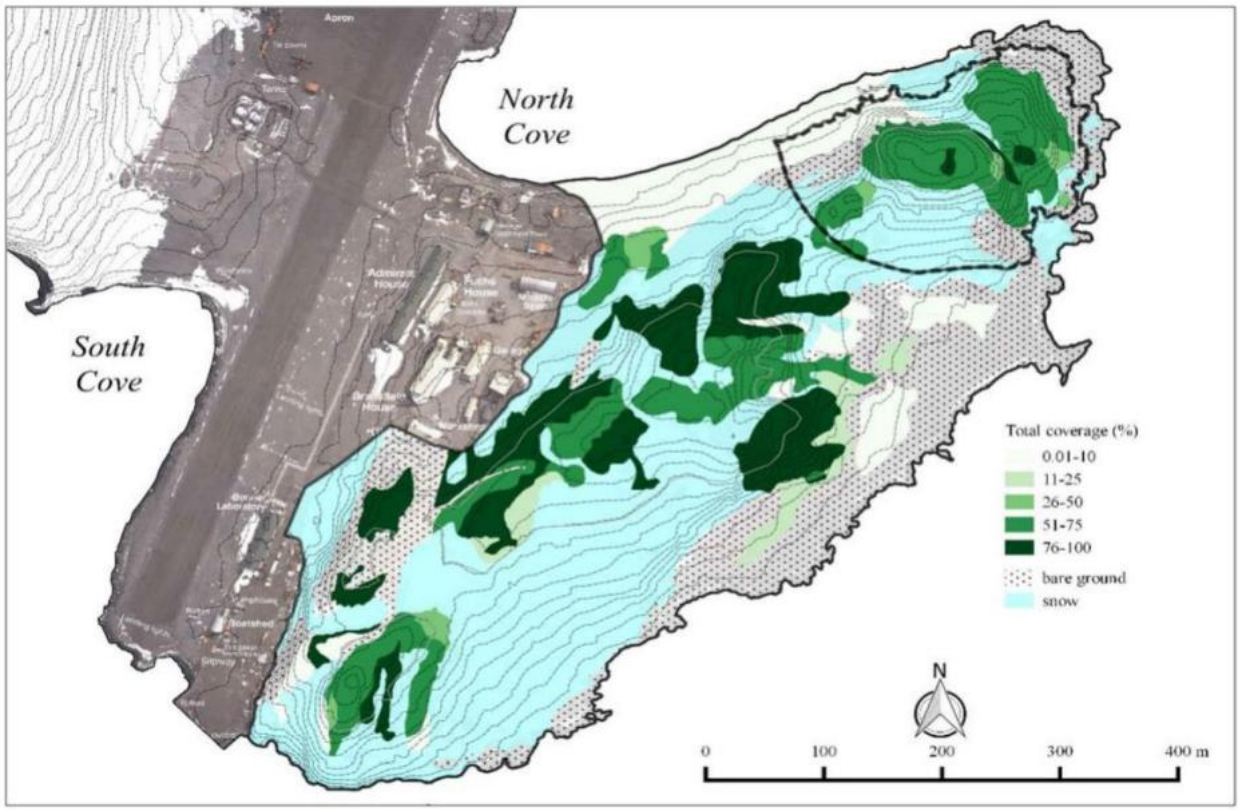

Figure 10-2 Total Vegetation Coverage (%) at Rothera (as of 2018).

Rothera contains no large areas of green vegetation, with substantial continuous moss and liverwort patches limited to a single area of approximately 100 m^2 adjacent to a transient melt stream in a gully 100 m south-southeast of NBH, Figure 10-3.

[25] Convey, P. & Smith, R.I.L. 1997. The terrestrial arthropod fauna and its habitats in northern Marguerite Bay and Alexander Island, maritime Antarctic. Antarct. Sci. 9, 12-26

[26] Ochyra, R., Bednarek-Ochyra, H. and Smith, R. I. L., 2008. The Moss Flora of Antarctica. Cambridge University Press, Cambridge. pp 704

Confirming this, analysis of remote sensing imagery (using Normalised Difference Vegetative Index (NDVI) methodology) revealed that areas of significant green vegetation are spatially limited. Areas of high NDVI value on East Beach relate to algae and cyanobacteria in ephemeral pools fed seasonally by melting snow and ice, shown in Figure 10-3. However, large, and dense concentrations of lichens and cryptogams are found across the Point, and in particular on rock bluffs.

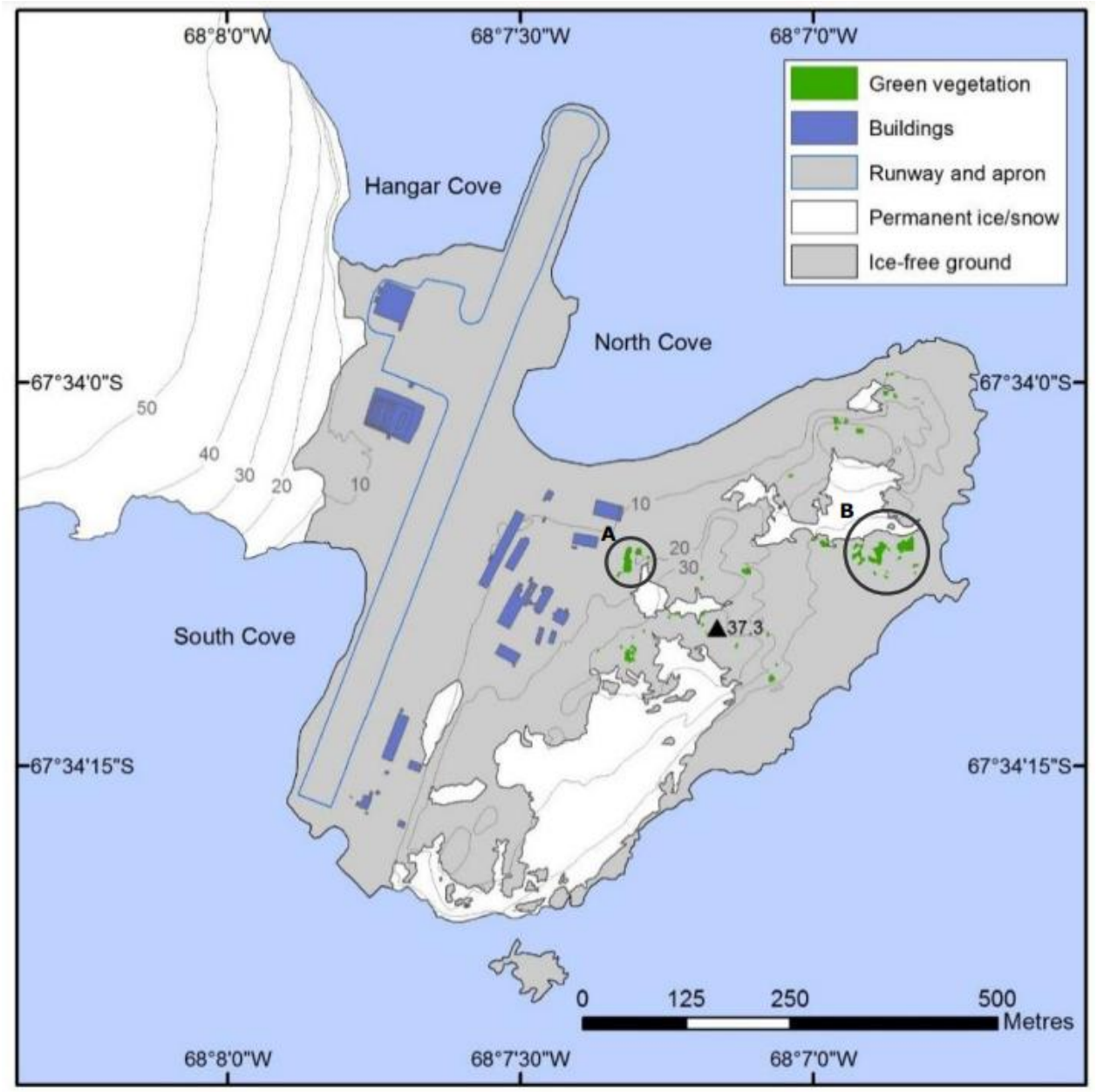

Figure 10-3 Areas of Green Vegetation Detected on Rothera. Areas A: Moss and Area B: Liverwort and Algal Vegetation

Cryptogams (Mosses, Liverworts, Lichens, Algae)

The vegetation is representative of the southern "maritime" Antarctic fellfield ecosystem and is dominated by the fruticose lichens Usnea antarctica, *Usnea sphacelala*, and *Pseudephebe minuscula*, and the *foliose lichen Umbilicaria decussata*[27,28]. Numerous crustose lichens are found, but bryophytes (mainly *Andreaea spp*.) are sparse. Lichen vegetation is well developed and diverse, dominated by crustose and foliose species, and is typical of the southern maritime Antarctic, as previously described. Bryophytes are generally sparse (mainly *Andreaea spp*).

Bryophytes are limited to two main habitats, these being around the relatively small areas of soil and sorted ground, and in rock crevice and epilithic habitats[26]. In the former habitat, although sparse on the summit plateau areas, there are some well-developed stands of *Andreaea spp*. especially below the western and south-western edges of the ASPA 129 *Rothera, and Sanionia sp*. especially below the eastern and south-eastern edges. These are intermixed with a small amount of what appears to be *Bryum sp.* and possibly also *Ceratodon and Cephaloziella*. Examples of crevice and epilithic species include *Bartramia* (some with *sporophytes*) and *Schistidium/Grimmia*.

The vegetation composition does appear to have remained constant since the mid-1990s and is being monitored annually for changes. The total area of moss cushions or carpets, while remaining small, may have expanded slightly, including habitats along the spine of Rothera, and in the sandy/silty areas of East Beach.

Vascular Plants

A single very small population of Antarctic pearlwort (*Colobanthus quitensis*) has been observed below the northern cliff of the ASPA. A small population of Antarctic pearlwort may continue to persist in a small gully at the base of crags under the ASPA's northwest cliffs. Sixteen separate plants or clumps of varying sizes were noted previously, at least two of which included mature and open seed heads; however, these plants are vulnerable to long-term burial by snow and their persistence is uncertain. A single plant of Antarctic hairgrass (*Deschampsia antarctica*) was located in a small depression at the northern edge of the summit plateau. This plant also possessed a single mature seed head.

Leafy liverwort, *Cephaloziella varians*, is present at Rothera and data has been collected on the mat temperatures, moisture concentrations and microscopy data on fungal structures in the tissues of the leafy liverwort exposed to warming for 10 years[29]. Field measurements were collected for percentage frequencies of fungal structures, temperature, and moisture concentration from an open top chamber (OTC) warming experiment on Rothera, Adelaide Island. The dataset proposed that the abundance of fine hyphal coils in leafy liverwort tissues might be used as a signal of recent climate warming on the Antarctic Peninsula[30].

Rothera is representative of some of the floristic diversity typical of vegetation communities of the north-western Antarctic Peninsula. Furthermore, Rothera along with Leonie Island (part of which is included in the newly designated ASPA 177 Leonie Islands and southeast Adelaide Island) are the two sites with the largest floristic richness and more complex vegetation within the wider geographical context of Marguerite Bay and Adelaide Island. As such the vegetation on Rothera is of outstanding value, contrary to earlier assessments.

[27] Øvstedal, D.O. and Smith, R.I.L., 2001. Lichens of Antarctica and South Georgia. A Guide to their Identification and Ecology. Cambridge University Press, Cambridge, 411 pp.

[28] Cannone, N., Convey, P., Malfasi, F., 2018. Antarctic Specially Protected Areas (ASPA): a case study at Rothera Point providing tools and perspectives for the implementation of the ASPA network in the Antarctic Peninsula. Biodiversity and Conservation 27: 2641-2660.

[29] Newsham, K. K. 2021. Mat temperatures, moisture concentrations and microscopy data on fungal structures in the tissues of the leafy liverwort Cephaloziella varians exposed to warming for 10 years on Rothera Point (Version 1.0) [Data set]. UK Polar Data Centre, Natural Environment Research Council, UK Research & Innovation. https://doi.org/10.5285/0502FE87-6A41-4529-B6C0-A9E5C30AADCB

[30] Newsham, K.K. 2021.Fine hyphal coils in the liverwort Cephaloziella varians increase in frequency in response to experimental warming in maritime Antarctica. Mycorrhiza, 31. 519-525. https://doi.org/10.1007/s00572-021-01037-2

10.1.2 Terrestrial Fauna

Studies of the terrestrial invertebrate fauna on Rothera are few, but as far as is known, the fauna is impoverished and consists only of a few species of mites and springtails, of which Halozetes belgicae and Cryptopygus antarcticus are the most common. Nematodes and rotifers have also been recorded in freshwater pools. Research has not identified any special or rare terrestrial fauna on Rothera. Extensive quarrying for rock to construct a 900 m airstrip in the early 1990s led to the draining of a small lake that caused the rare crustacean Boeckella poppei becoming locally extinct at Rothera.

10.2 Marine Benthic Communities

10.2.1 Shallow Water

The shallow seas of Marguerite Bay (0-30 m) are within the Southern Ocean, the coldest ocean on Earth with one of the smallest annual temperature ranges; typically, -2 to +2 °C. In contrast, shallow polar waters experience one of the highest seasonal changes in primary productivity as the photoperiod changes from 24-hour daylight to 24-hour darkness between summer and winter. Shallow water communities are also subject to high levels of disturbance from the impact of icebergs. However, while this might be considered a harsh physical environment, many marine benthic species flourishes in the shallow waters. Many of these species show adaptations to life in the Southern Ocean, for example, limited temperature tolerance and seasonal energy saving strategies.

The shallow waters off the Western Antarctic Peninsula have experienced rapid warming over the last 50 years, which has led to reductions in sea ice, melting of glaciers and higher levels of iceberg disturbance. The change in the cryosphere has already led to changes in the patterns of primary productivity, which are expected to combine with warming and ocean acidification to result in severe impacts on shallow marine benthic communities.

Iceberg disturbance is a major structuring force of shallow water polar communities, particularly those living on rocky reefs. The very high disturbance levels in the shallows result in a fauna that is dominated by mobile species that are able to rapidly recolonize areas after an iceberg impact. Typically, this fauna consists of high numbers of gastropod molluscs and echinoderm species. It is only in deeper water, or in sheltered locations, where iceberg disturbance is reduced sufficiently that sessile communities can develop.

To determine the baseline state of marine benthic communities, surveys were conducted in January 2016 on three sites off the south coast of Rothera in depths of 9-10 m. The sites were, below the front of the current Wharf (67.5723 S, 68.1296 W), the end of the runway (67.5717 S, 68.1312 W) and inside of South Cove (67.5697 S, 68.1319 W). The survey followed reef life survey methodology[31], which provides a global standard to facilitate description, monitoring, and comparison of rocky reef marine communities.

The bottom consisted of a mixture of bed rock and loose cobbles with occasional pockets of mixed cobbles and sediment. The end of the runway had the highest proportion of bedrock with the steepest underwater gradient. The gradient was shallowest in South Cove and the substratum subsequently had the highest number of pockets of mixed cobbles and sediment. The Wharf was an intermediate slope, but the substratum largely consisted of loose cobbles. Whilst macro algae were relatively scarce in the shallow polar waters examined, there were occasional large clumps of the brown alga *Desmorestia antarctica* and an algal mat covered some of the seabed.

Community analysis, Figure 10-4, showed a high degree of variation in density between species, but all three sites had similar diversity and densities of species. At all three sites, the most abundant species was the Antarctic limpet, *Nacella concinna*, with up 112 individuals per m^2, and the most speciose class was the Asteroidea with either four or five species. Fish numbers were very low, with only five individuals counted during the three surveys.

[31] https://reeflifesurvey.com/

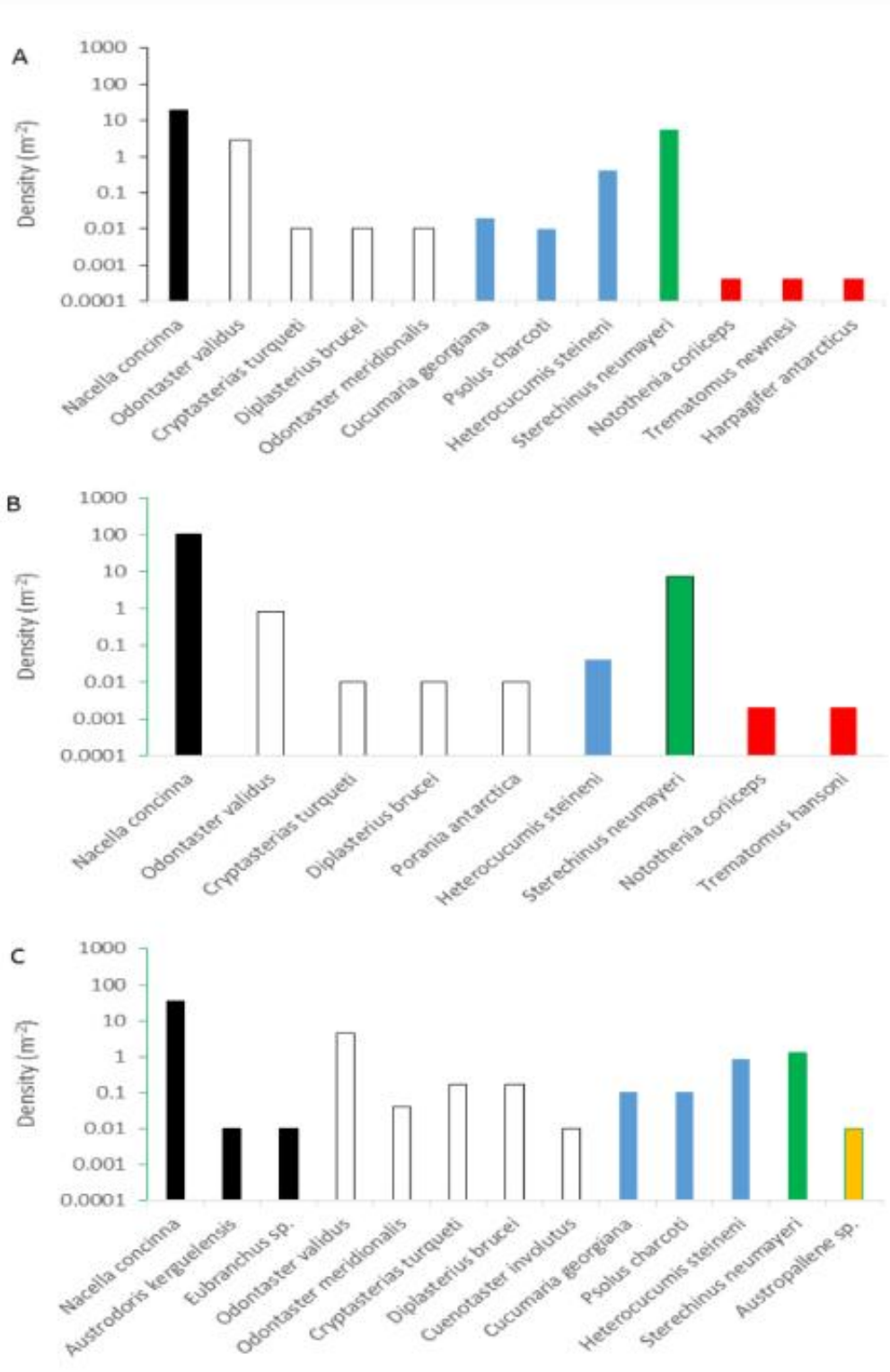

Figure 10-4 Species densities from SCUBA diver counts in depths of 9-10 m, A) Wharf, B) end of runway and C) South Cove. Black bars – snails and sea slugs, open bars – sea stars, blue bars – sea cucumbers, green bar – sea urchin, yellow bar – sea spider BAS Jan 2022

Further data has been collected since 2016 including in situ growth and physiological data from two Antarctic anemone species, *Isotealia antarctica and Urticinopsis antarctica*, at Rothera between 2020 and 2023[32]. The study involved Antarctic predator growth and seasonal physiology, field growth rates being measured for two soft-bodied Antarctic anemone benthic predators, *Isotealia antarctica* and *Urticinopsis antarctica*, using in situ sampling of anemones on uniquely marked tiles from Rothera from 2020-2023. Ex-situ measurements of oxygen consumption and seven-day faecal output were obtained from recently collected specimens in aquaria and compared between summer and winter. The data collected suggests that the anemone is sensitive to temperature as the growth rate decreased during the colder months and increased exponentially during the warmer months.

A dataset published in 2022[33] of the *Laternula elliptica* developmental stages of molluscs collected from Hangar Cove at Rothera on Adelaide Island. The dataset provides insight into why molluscs produce shells with diverse morphologies and ornamentations, different colour patterns and microstructures depending on genes.

10.2.2 Changes in Ice Scour of the Benthic Environment

Losses of fast ice around Rothera have led to higher iceberg scouring rates and rising mortality of some benthic species. Daily records of fast-ice presence/absence from 1986 to 2010 and annual ice-scour impact rates have shown a decreasing trend in the duration of fast-ice years and a coincident increase in scouring. However, three more years of data revealed that this is more aptly described as a decrease to a tipping point in 2006, after which fast-ice has been anomalously brief each year and ice scour has been high.

The annual survey of iceberg disturbance at Rothera is thought to be the longest running and most comprehensive direct measure of marine ice disturbance. The number of annual iceberg impacts has, similarly to fast ice, varied much between years but impacts have increased in recent years. The fewest impacts matched the years which had the longest duration of fast-ice within the study period and likewise the years with most impacts were the two years with briefest fast-ice. Fast-ice duration explains 72.4% of the variation in annual ice scour. Markers at 5 and 10 m depth were hit more than twice as often as those at 25m. The link between fast-ice duration and iceberg scouring is important because scouring is the dominant cause of mortality to fauna in the shallows.

Previous work has shown that survival from ice scouring at this depth can be less than 1% of the fauna. Both the shallows and deep shelf are mosaics of faunas recovering from impacts; the former is dominated by pioneers and free space whilst the latter are a mixture including ‘climax’ assemblages perhaps thousands of years old. This study was conducted in South Cove, which is generally shallower and more sheltered than the Wharf area. It is likely that impact damage around the Wharf could be more severe due to the larger scale of icebergs that can reach the Wharf due to the deeper water and steeper seabed slope angle.

[32] Frontier, N., Marlow, J., Giles, A., Clark, M., Morley, S., & Peck, L. 2024. In situ growth and physiological data from two Antarctic anemone species, Isotealia antarctica and Urticinopsis antarctica at Rothera Research Station (2020-2023) (Version 1.0) [Data set]. NERC EDS UK Polar Data Centre. https://doi.org/10.5285/221909cf-eac3-4a64-b1d0-3c1cdccdfe3c

[33] Sleight, V., Clark, M., & Cavallo, A. 2022. Laternula elliptica developmental bulk RNA-Seq data analysis results 2022, collected from Hangar Cove Rothera Point, on Adelaide Island in 2018 (Version 1.0) [Data set]. NERC EDS UK Polar Data Centre. https://doi.org/10.5285/6cd12de1-02c7-4f94-86f0-c11e76b86067

10.3 Marine Invertebrates

In 2022, BAS published blue carbon data for marine invertebrates living on soft substrata (20 m South Cove and Hangar Cove) and rocky substrata (Cheshire Island) around Rothera[34]. Marine soft sediment habitats are some of the most widespread in the ocean and play a vital role in global carbon cycling, particularly in the Polar regions, while understanding of the species composition and ecosystem function is the most limited. Polar sediment habitats also experience additional environmental drivers of strong seasonality and intense disturbance from iceberg scouring, which are major structural forces for hard substratum communities.

The BAS End of Season Report 2023 – 2024 Rothera Runway Extension Biodiversity Survey[35] identified 73 unique morphotaxa using light microscopy from six sites sampled from the North Turning Circle between Hangar Cove and North Cove for the eDNA characteristics from triplicate water samples obtained from 1 m above the seabed, middle of the water column, and surface.

10.4 Antarctic Anemone

A study in 2024 explored the growth rates for two soft-bodied Antarctic anemone benthic predators including *Isotealia* antarctica and *Urticinopsis* antarctica. This study was undertaken as there is an important data gap because species inhabiting the Southern Ocean live in a more temperature stable but seasonally varying environment than temperate and tropical counterparts. For many species living below 0 °C for a significant proportion of the year, bodily functions are slowed to disproportionately lower rates than would be predicted by temperature alone. Certain life history and physiological processes are often aligned with the short summer season of productivity. However, predators may behave differently because they are decoupled from the phytoplankton bloom, and some have been shown to exhibit less seasonal physiological change[36]. Therefore, Antarctic Anemone are present in the ocean surrounding Rothera and are sensitive to changes in temperature and marine conditions.

10.5 Avifauna

Birds are seen commonly around Rothera between late September/early October and March and far more rarely in winter.

10.5.1 Breeding Species at Rothera

For a comprehensive review of birdlife at Rothera, including reference to relevant literature[37] of the species observed in the vicinity of Rothera, only some are known to breed: snow petrel (*Pagodroma* nivea), Wilson's storm petrel (*Oceanites oceanicus)*, imperial/Antarctic shag or cormorant (*Phalocrocorax [atriceps] bransfieldensis*), south polar skua (*Catharacta maccormicki*), and kelp/Dominican gull (*Larus dominicanus*) and Antarctic tern (*Sterna vittatta*). On Rothera itself, south polar skuas are the most abundant breeding birds with occasional pairs of kelp gulls nesting and one Wilson's storm petrel nest has been found[38].

[34] Morley, S., Souster, T., Gerrish, L., Vause, B., Peck, L., & Barnes, D. (2022). Blue carbon data for marine invertebrates living on soft substrata (20m South Cove and Hangar Cove) and Rocky substrata (Cheshire Island) around Rothera Point Antarctica (2013-2015). (Version 1.0) [Data set]. NERC EDS UK Polar Data Centre. https://doi.org/10.5285/f3fe6bff-fefd-48d4-8024-dfb3e33a818f

[35] BAS, 2024. End of Season Report 2023-2024 Rothera Runway Extension Biodiversity Survey.

[36] Frontier, Nadia and Marlow, Joseph and Morley, Simon A. and Giles, Adriana and Clark, Melody S. and Peck, Lloyd S. 2024. Growth and Physiology of Two Antarctic Benthic Predators; Isotealia Antarctica and Urticinopsis Antarctica. Available at SSRN: https://ssrn.com/abstract=4721176 or http://dx.doi.org/10.2139/ssrn.4721176

[37] Milius, N. (2000), The birds of Rothera, Adelaide Island, Antarctic Peninsula. Marine Ornithology 28: 63-67.

[38] Phillips, R.A., Silk, J.R.D., Massey, A., and Hughes, K.A. (2019). Surveys reveal increasing and globally important populations of south polar skuas and Antarctic shags in Ryder Bay. Polar Biology 42: 423–432

Snow Petrel (*Pagodroma nivea*)

The Ornithology EIA for Operation of Wind Turbines at Rothera[39] undertaken in 2024 identified no breeding pairs within the Rothera population. The snow petrel will still be considered in this IEE as snow petrels may breed in small numbers and are recorded throughout the year around Rothera, though less often in early and mid-summer. It is possible that they breed on some of the rock outcrops in the Rothera area.

Wilson's storm petrel (*Oceanites oceanicus*)

The Ornithology EIA identified breeding pairs of Wilson's storm petrels at Rothera, however the exact number of breeding pairs within the population was not recorded. This species may breed in small numbers on Rothera, probably less than 15 pairs, although breeding pairs have been identified on many (maybe all) of the other local islands in Ryder Bay, e.g., Lagoon Island. Birds return in late November or early December and although records are few, their departure is likely to be during April.

Imperial shag (*Phalacrocorax [atriceps] bransfieldensis*)

Up to 24 pairs of the Antarctic Shag or Cormorant breed on a small rock just to the north of Killingbeck Island, c. six pairs on the north end of Killingbeck Island and c. 50 pairs on another small rock close to Lagoon Island, although the exact numbers may vary considerably between years. A further colony located on Skart Island (Mikkelsen Islands) was discovered in January 2018 and contained 80 pairs[38]. Imperial shags can be seen at all times of the year, although their presence in winter is likely to be dependent on sea-ice conditions. Between late March and late June 1996, large flocks containing 300–400 adult and juvenile birds were seen with over 1000 recorded on 22 June, indicating that more than just the local breeding population was present.

South polar skua (*Stercorarius maccormicki*)

Rothera and adjacent islands contain over 10% of the global population of south polar skuas and the area is of international importance. In austral summer 2017/18, totals of 259 skuas at club sites and 978 occupied skua territories were counted, in 2.3 km^2 of suitable habitat across Rothera and the islands in Ryder Bay. The EIA undertaken in 2024 identified 26 breeding pairs of south polar skua within the population at Rothera.

South polar skuas breed at Rothera and the population has been monitored annually since the 1988/89 season. The locations of recorded nest sites are shown in Figure 10-5. Nest sites are often reused but may be inactive for a number of consecutive years.

[39] Whiltelaw, P., Phillips, R., Fijn, R., Hughes, K., Frontier, N., Stuart, E., and Fothergill, C. 2024. Ornithological Environmental Impact Assessment for Operation of Wind Turbines at Rothera Research Station.

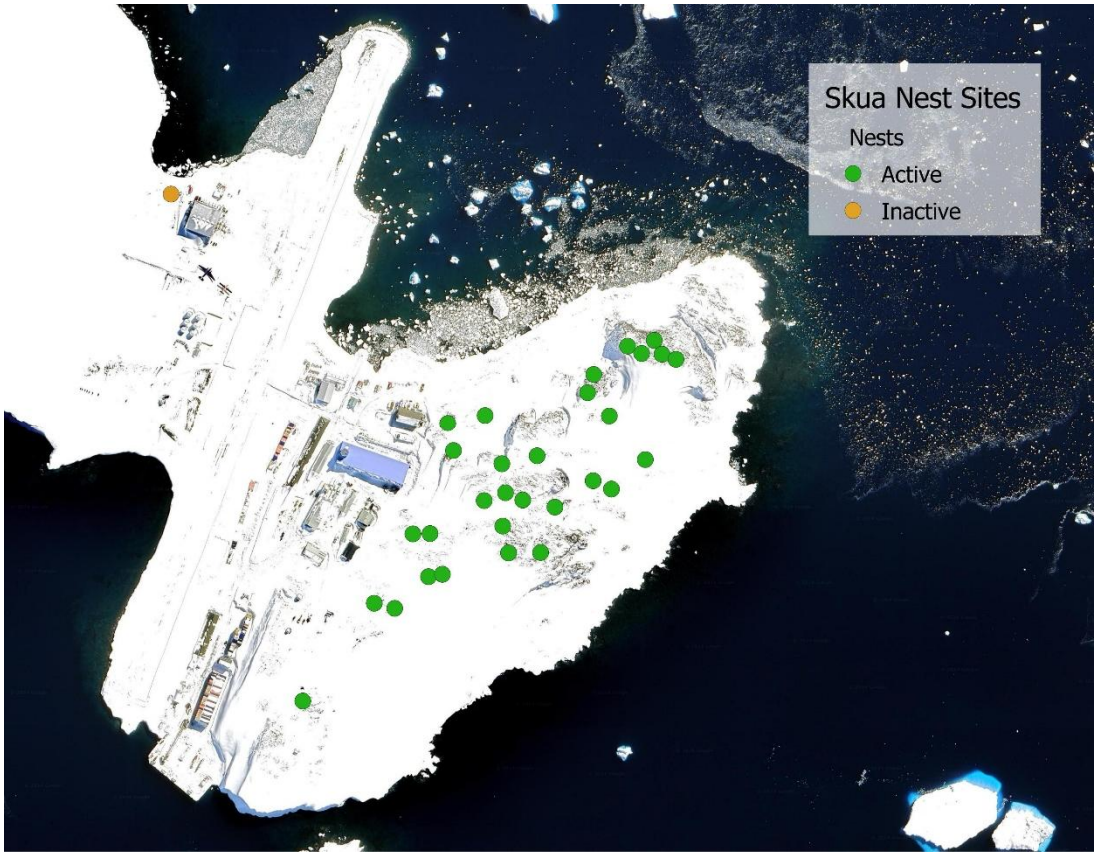

Figure 10-5 Approximate Distribution of Skua Nest Sites at Rothera, BAS 2024

Long-term data indicates that the population size at Rothera varies considerably between years, increasing overall by 1.9% per annum from 11 breeding pairs in 1975/76 to 24 breeding pairs in 2017/18, shown in Figure 10-6 and Figure 10-7. Birds are known to breed on many of the other islands in Ryder Bay (Lagoon, Leonie, Killingbeck, Donnelly and Anchorage Islands) and at least one incubating pair has been observed on Reptile Ridge. The spring return to Rothera usually falls between 15 and 25 October with departure in late April/early May, with the latest birds likely to be migrants from farther south. At Rothera, large numbers of non-breeding skuas (up to 200) congregate in communal areas, often near shallow melt pools and at either end of the runway.

Ongoing monitoring of skua breeding takes place at Rothera to ensure that impacts as a result of human presence there are monitored and managed, if required.

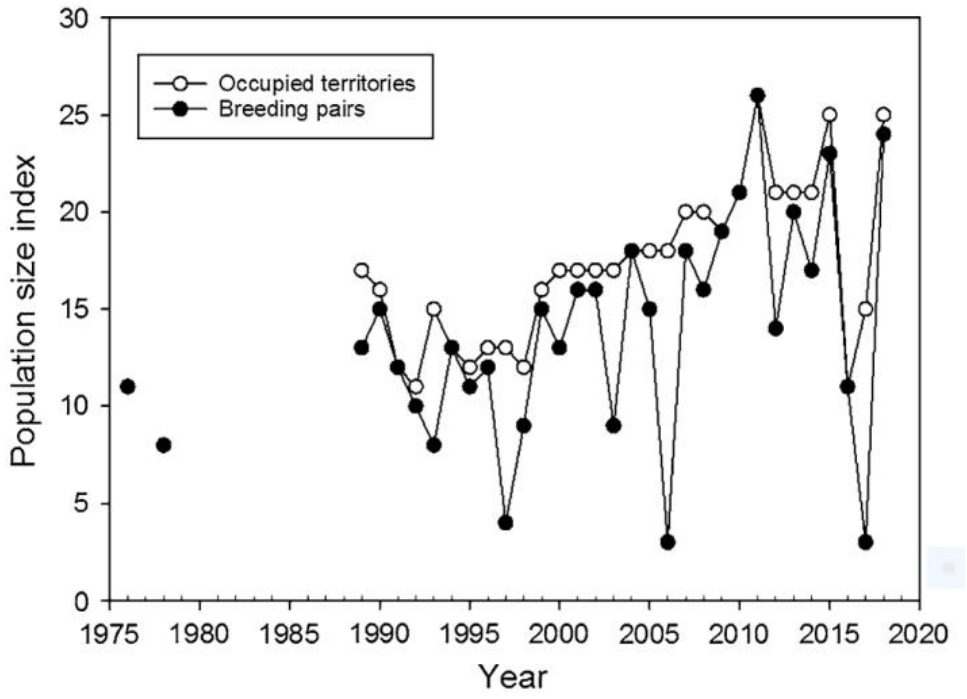

Figure 10-6 Changes in Population Sizes of South Polar Skuas at Rothera 1976 to 2018. Years Refer to the Time of Chick Fledging (I.E. 1976 Represents the 1975/76 Austral Summer), BAS 2022

Figure 10-7 Location Map of Ryder Bay and Surrounding Area, BAS 2022.

Kelp Gull (Larus dominicanus)

The Rothera breeding population varies from c. zero to four pairs. This species also breeds on the other local islands (Killingbeck, Lagoon, Anchorage and in larger numbers on Leonie). In winter, kelp gulls are one of the most regularly recorded species at Rothera. The Ornithology EIA undertaken in 2024 identified two breeding pairs within the population at Rothera.

Antarctic tern (*Sterna vittata*)

Breeds locally, on Killingbeck Island, Reptile Ridge (approximately 100 pairs) and on Lagoon Island and possibly Anchorage Island. About 60 terns, some of which were on nests, were noted on Rothera in February 1962, while Killingbeck (1963) and Willey (1969) reported a nesting colony of more than 100 birds at Rothera on 16th January 1969. However, the colony disappeared after the establishment of the base in 1976. The Ornithology EIA undertaken in 2024 identified that there have been breeding pairs of Antarctic terns in some years within the population at Rothera. Birds are seen commonly around Rothera between late September/early October and March and far more rarely in winter.

10.5.2 Non-Breeding Species at Rothera

Emperor Penguin (*Aptenodytes forsteri*)

Emperor penguins are rare, although almost annual, visitors, with seldom more than single birds seen. A group of 19 was recorded on 7th November 1977 (Fletcher 1978). Nearly all records of this species fall between August and November.

Adélie Penguin (*Pygoscelis adeliae*)

Seen almost daily during the summer months (late October to March) and less frequently, but still regularly, throughout the remainder of the year. In summer, counts vary greatly with up to c. 120 birds observed on East Beach at one time. Winter occurrence is probably largely dependent on sea ice coverage; available records suggest that they become quite scarce when the sea ice is at its most extensive. During February and March, many of the birds present come ashore to moult. From late February to April, a small number of first-year birds are regularly recorded, although during the winter almost all birds are adults. Fragments of bone and eggshell in soil provide evidence of ancient penguin, probably Adélie penguin, colonies on Rothera.

Chinstrap Penguin (*Pygoscelis antarctica*)

Rare summer visitor with records usually involving single birds between January and March.

10.6 Marine Mammals

10.6.1 Seals

Seals haul out at low lying sites around Rothera, Figure 10-8. Weddell seals (*Leptonychotes weddelli*) are the most obvious mammal and are present all year round. In late September, pups are born out on the sea ice. Crabeater seals (*Lobodon carcinophagus*) and elephant seals (*Mirounga angustirostris*) are also present, and fur seals (*Arctocephalus gazelle*) arrive in varying numbers at the end of each summer. Increasing numbers of both elephant and fur seals have been experienced in the last few seasons at Rothera and whilst no scientific surveys have been undertaken to establish the actual numbers of individuals, operational tasks have been impacted by the presence of seals on roadways and the runway. The leopard seal (*Hydrurga leptonyx*) is present all year round.

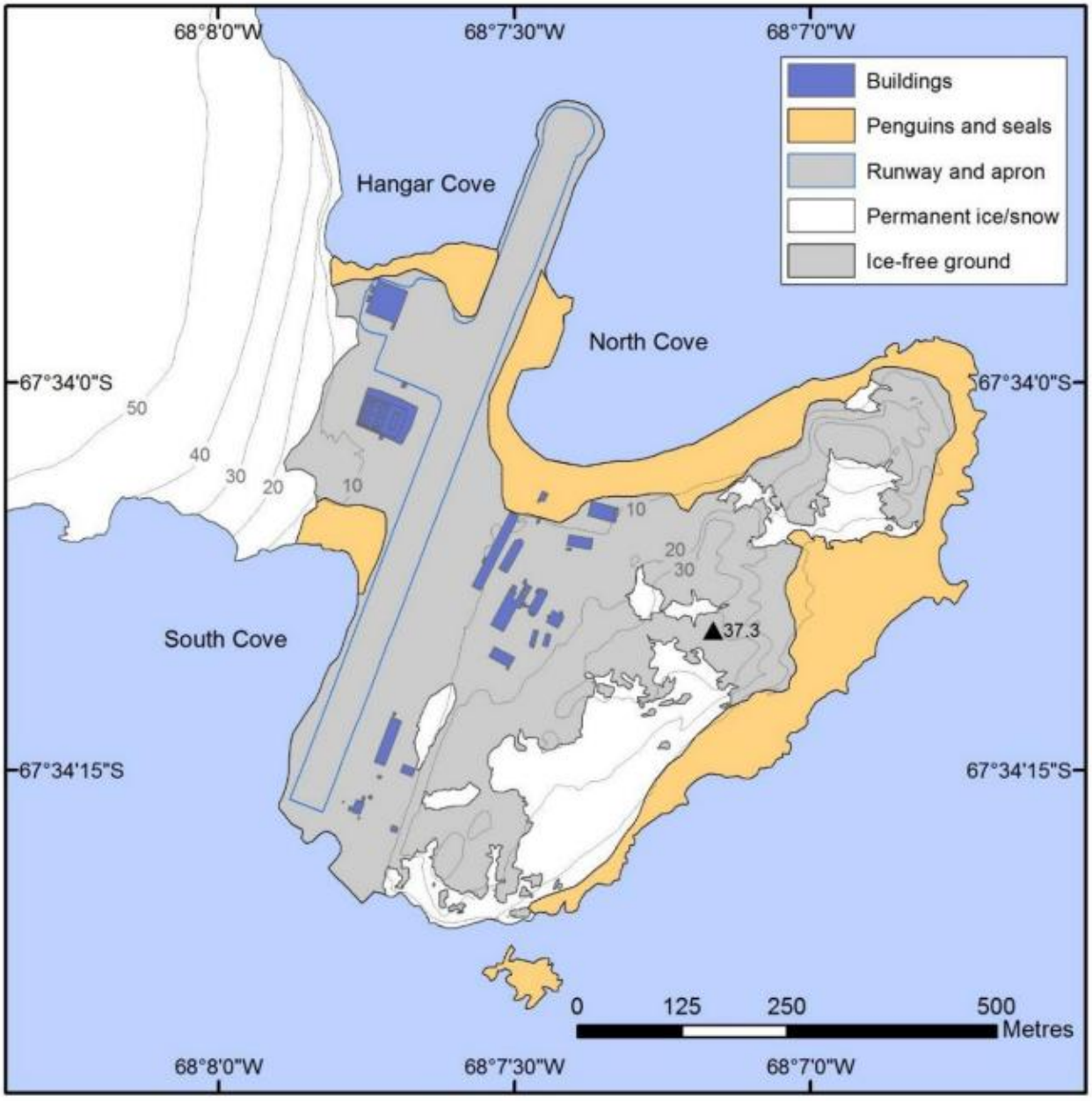

Figure 10-8 Low Lying Area of Rothera Where Low Densities of Seals and Penguins May Be Found Commonly, BAS 2022

Whales

A marine mammal survey at Rothera was undertaken in 2020[40] which recorded a total of 67 sightings and 124 individuals were recorded between Signy and Rothera research Station. Ten Orca (*Orcinus orca*) were observed across four sightings. A unique sighting of a Curvier's beaked whale (*Ziphius cavirostris)* was recorded by the ship's watch-keeper at 61°S. Thirty-eight Humpback whales (*Megaptera novaeangliae)* were identified across 21 sightings. Twenty-one Fin whales (*Balaenoptera physalus)* were identified across 10 sightings. Five Antarctic Minke whales (*Balaenoptera bonaerensis)* were identified across five single sightings, two of which were amongst floes in the Lemaire Channel. Twenty-six sightings comprising 49 individual unknown whales were recorded.

[40] Mathews, R., & Frontier, N. 2020. An opportunistic Marine Mammal survey between Harwich, UK and Rothera Research Station, Antarctica (Version 1.0) [Data set]. NERC EDS UK Polar Data Centre. https://doi.org/10.5285/e50b1244-eed7-4bd9-a2ab-de1b172b69b3

Minke whales (*Balaenoptera bonaerensis*) and humpback whales (*Megaptera novaeangliae*) are seen in Ryder Bay each summer. During some years minke whales can be observed frequently and may be year-round residents, including within the ice pack if present. There is little evidence for substantial blue or fin whale activity in Marguerite Bay[41]. Killer whales (*Orcinus orca*) are usually seen from Rothera several times each summer.

Humpback whales are seasonal residents, migrating between tropical breeding and calving grounds to feed along the Western Antarctic Peninsula in austral summer and autumn months. There are areas within Marguerite Bay with high krill predator occurrence rates including the area around Rothera and the northern extent of Marguerite Bay near the southeastern end of Adelaide Island[42] .

10.7 Non-Native Species

No non-native plants or invertebrates are known from Rothera or the adjacent marine environment. However, there was a report, dating from the mid-1990s, of the non-native collembolan *Hypogastrura viatica* at Leonie Island, Marguerite Bay[43,44]. This is the most southerly record of the presence of a non-native species in the natural environment on the Antarctic *Peninsula.* A monitoring project was initiated in January 2015 to establish the presence and distribution of *Hypogastrura viatica* on the islands in Marguerite Bay and on Rothera. No evidence for the presence of *Hypogastrura viatica* or any other non-native invertebrate was found in the c. 36,796 specimens collected. From these data it cannot categorically be stated that *Hypogastrura viatica* is absent from the area, but given the number and distribution of samples collected, it is likely that it is present in only very low numbers, and it is possible that it has become locally extinct.

10.8 Physical Characteristics

10.8.1 Meteorological Conditions

A programme of surface synoptic meteorological measurements commenced at Rothera in 1977. The climate is cold and dry and represents a transition from that typical of the more oceanic influenced ‘maritime’ Antarctic to the north and the more extreme climate of ‘continental’ Antarctica to the south. Mean monthly air temperatures range between - 10.5 and + 1.4 °C. The prevailing wind is north-north-easterly and averaging at 12.1 ms^{-1}, but often exceeding 20 ms^{-1}.

[41] Širović, A., and Hildebrand J. A. 2011. Using passive acoustics to model blue whale habitat off the Western Antarctic Peninsula. Deep-Sea Research Part II 58:1719-1728.

[42] Friedlaender, A.S., Johnston, D.W., Fraser, W.R., Burns, J., Halpin, P.N., Costa, D.P. 2011. Ecological niche modeling of sympatric krill predators around Marguerite Bay, Western Antarctic Peninsula. Deep Sea Research II 58: 1729–1740.

[43] Hughes, K. A., Pertierra, L.R., Molina-Montenegro, M. A., Convey, P. (2015), Biological invasions in terrestrial Antarctica: what is the current status, and can we respond? Biodiversity and Conservation, 24. 1031-1055.

[44] Hughes, K. A., Greenslade, P., and Convey, P. (2017), The fate of the non-native collembolon, Hypogastrura viatica, at the southern end of its introduced range in Antarctica. Polar Biology 40: 2127-2131.

10.8.2 Air Quality

No air quality data exist for Rothera, however significant volumes of hydrocarbons are combusted in the vicinity of Rothera by generators and the engines of vehicles, ships, small boats, and aircraft. Rothera also has an incinerator which emits combustion gasses. Monitoring of heavy metals in lichens on Rothera undertaken between 1976 and 1989 showed pollution close to Rothera, particularly those areas affected by diesel generators and within c. 200 m to the north-west, north, and north-east of Rothera, corresponding with the prevailing wind directions[45]. Beyond this area the concentrations progressively declined with increasing distance from Rothera. Substantial levels of building activity in recent years have generated dust, but the levels have been minimised through the use of dust suppression techniques. The frequently high to moderate wind speeds in the area may rapidly disperse any pollutants, so minimising any impacts beyond the immediate vicinity of the pollution sources. Dust monitoring has occurred during recent construction seasons, although the accuracy of such data is under review; prior to the RUNSUR project aircraft generated significant levels of dust. The latest dust monitoring was undertaken in the 2023-2024 Season, in which there were an exceedance was reported which was thought by site personnel to have been caused by an aircraft generating significant amounts of dust.

10.8.3 Tides and Waves

Tides

The tides at Rothera are diurnal (i.e., one high tide and one low tide each day). On some neap tides the difference between high and low water can be very small, Table 10-1.

Table 10-1 Astronomical tides for Rothera are given on Admiralty chart 3462 as follows (CD: chart datum)

State of the Tide	Level
Mean Higher High Water (MHHW)	+1.3 m CD
Mean Lower Low Water (MLLW)	+0.4 m CD
Mean Sea Level (MSL) - taken as the mean of MHHW and MLLW	+0.85 m CD

Waves

Based on preliminary calculations using a wind speed of 40 knots (3-hour average), a 50-year return period wave height of Hs = 4.0 m is estimated.

10.8.4 Bathymetry

The seabed around Rothera shelves steeply and depths in excess of 500 m can be found within 5 km of Rothera. Water less than 50 m deep is restricted to the immediate fringes of the coastline. Currents along the coastline are minimal; however, the channel between Rothera and Killingbeck Island experiences current speeds in excess of 0.5 knots.

A bathymetric survey was conducted at the former Biscoe Wharf during February 2016. The seabed was found to be steeply sloping (majority steeper than 25° angle) and consisted primarily of rock. Seawater depths reach 40 m within close proximity of the shoreline (c. 25 – 35 m).

[45] Bonner, W.N., Lewis-Smith, R.I., and Walton, D.W.H. (1989), Final Comprehensive Evaluation for the proposed construction of an airstrip at Rothera Point, Antarctica. NERC, Swindon.

10.8.5 Geomorphology

Rothera is a small peninsula situated on the southeast of Adelaide Island. Rothera is a low rocky headland of about 0.4 km^2 comprising a north-east to south-west trending, dissecting ridge rising to 39 m altitude, an area of raised beach composed of rounded boulders on the southeastern side and similar but more extensive terrain (though composed of smaller stones and pebbles) on the north-west side. The latter forms an isthmus between North and South Cove and connects Rothera itself to Adelaide Island. The isthmus was extensively altered and widened during the construction of the gravel runway in the early 1990s. The sloping ice-ramp with a gradient of about 1:5 leads from the isthmus to the Wormald Ice Piedmont.

The rocks of Rothera have been subject to extensive frost shatter although some areas have been smoothed by the action of ice that has since retreated. A large ice-dammed melt pool that used to exist where Rothera now stands had disappeared by the early 1970s; its former shorelines were distinguished by more than 20 narrow terraces, but these are now largely indistinguishable due to station construction activities[46]. Several poor-quality raised beach terraces are present on East Beach representing previous higher sea level episodes, and the process of isostatic rebound is thought to be on-going in the area. Raised beaches are also evident on the neighbouring Anchorage and Leonie islands and occur at 6 m, 18 m, and 23 m above sea level (ASL). Other areas of ice-free topography are widespread elsewhere in Laubeuf Fjord and northern Marguerite Bay, but few possess extensive level ground.

10.8.6 Soils

Soil is restricted to small pockets of glacial till and sand intermixed with relictual penguin guano in depressions and amongst the rocks[47]. Deeper deposits have permafrost and occur as scattered small circles and polygons of sorted material. There are no extensive areas of patterned ground and periglacial features are poorly represented. There are frequent accumulations of decaying limpet (*Nacella concinna*) shells deposited by gulls (*Lars dominicanus*), forming patches of calcareous 'soil.' The disappearance of snow and ice patches during the past 30 years has revealed deposits of organic mud, feathers and bones derived from an ancient Adelie penguin rookery[48]. Otherwise, there are no accumulations of organic matter, except for a very shallow layer of decaying moss peat beneath patches of moss.

10.8.7 Surface Water

No large areas of freshwater exist on Rothera, except for a c. 50 m long transient pool located at the west fringe of the large area of permanent ice to the south of Rothera. Seasonal meltwater from the permanent ice feeds into this water body, which consequently fluctuates in level. During winter, and sometimes extending into the summer months, the surface of the water is not visible due to ice and snow cover. The pool was partially infilled during the 2018 - 2019 Season. Should the landscape topography be altered in this region, appropriate drainage from this pool may need to be considered.

Transient streams may form at other locations around the Point, with flow rate depending upon the season and level of melt of the associated snow and ice bodies. The large relatively flat area of ground at East Beach may contain transient pools that may support algal, moss and cyanobacterial communities. The flat area to the west of the Hangar may contain small transient meltwater pools.

[46] Shears, J. R. (1995), Initial Environmental Evaluation – expansion of Rothera Research Station, Rothera Point, Adelaide Island, Antarctica. British Antarctic Survey, Cambridge, 80 pp.
[47] Antarctic Treaty Secretariat, (2017), Management Plan for Antarctic Specially Protected Area No. 129 Rothera Point, Adelaide Island. Available at: http://www.ats.aq/devPH/apa/ep_protected.aspx?lang=e
[48] Emslie, S.D., McDaniel, J. (2002), Adelie penguin diet and climate change during the middle to late Holocene in northern Marguerite Bay, Antarctic Peninsula. Polar Biology 25, 222-229.

10.8.8 Geology

The stratified rocks of central Adelaide Island are probably of Late Jurassic age, based on similarities to rocks from elsewhere on the west coast of the Antarctic Peninsula[49]. The lithological unit that is directly relevant to Rothera and the surrounding area is the 'Adelaide Island intrusive suite'; a series of isolated and composite granitoid plutons. A large part of the exposed geology on Adelaide Island consists of plutonic rocks of the Adelaide Island intrusive suite. Many of the plutons on Adelaide Island are heterogeneous and are characterised by concentrations of well-rounded xenoliths, which are typically more mafic than the host. The plutons are seen to intrude the volcano-sedimentary sequences at several localities, including Reptile Ridge which lies at the top of the Rothera ice ramp.

The geology around Rothera is dominated by granodiorite, with minor amounts of quartz diorite and diorite. The geology of Rothera is interpreted to be consistent with the rest of the Adelaide Island intrusive suite and is therefore thought to be approximately 48 Ma (*Eocene age*). The mineralogy of the Rothera granodiorite consists of plagioclase, quartz, amphibole, biotite and variable amounts of chlorite and epidote, which has formed along cracks and joints in the rock, as a result of hydrothermal alteration. Malachite (copper) mineralisation is also a characteristic of the granodiorites of the Wright Peninsula and Rothera.

Close to the Memorial on Rothera, the primary lithology is granodiorite, although it is frequently characterised by abundant rounded mafic patches within the granodiorite host. The mafic 'blebs' are gabbroic in composition and are distinct to the xenolith-hosted granodiorite. The formation of this feature would have meant that the mafic blebs (*gabbro*) were relatively hot and less viscous compared to the 'colder' and more viscous granodiorite magma, therefore the gabbro would have 'frozen' when intruded into the granodiorite magma. This process where the gabbro and granodiorite magmas remain as distinct, recognizable rock types rather than becoming completely mixed is called 'magma-mingling'. With magma mingling there are some chemical interactions between the two magmas by slow and complex diffusional processes, but thermal equilibrium is reached long before chemical equilibrium, so the effects on the granodiorite composition are relatively minor.

Particle size analysis (PSA) was undertaken in the bay between Hangar Cove and North Cove out to sea from the North Turning Circle as part of the BAS End of Season Report 2023 – 2024 Rothera Runway Extension Biodiversity Survey[34] sediment of size 4 mm and above varies more in its contributions to the total mass than other size classes within and between sites. In the smaller grain sizes, it appears that there are more 63 µm material in all sites other than one which was surveyed.

10.8.9 Glaciology

Access from Adelaide Island to Rothera is via an ice ramp forming the southern limit of the Wormald Ice Piedmont, Figure 10-9.

[49] Riley. T. R., Flowerdew, M. J. and Whitehouse, M. J. (2012), Chrono- and lithostratigraphy of a Mesozoic–Tertiary fore- to intra-arc basin: Adelaide Island, Antarctic Peninsula. Geological Magazine 149: 768-782.

Figure 10-9 Ice Ramp that Connects Rothera to the Wormald Ice Piedmont, BAS 2022

The surface elevation of the ramp rises from 10 to 110 m ASL, over a horizontal distance of around 600 m. Following the establishment of the scientific station in 1975, the ramp saw considerable year-round vehicle traffic, largely in support of aircraft operations from a skiway on the piedmont. This traffic increased steadily over the years. In early 1990, construction of a gravel runway between the station and ramp began and by 1992 all aircraft operations had been transferred to this runway. Subsequent traffic on the ramp has been light. A survey programme was initiated in February 1989 to monitor the ice ramp's mass balance and to detect any changes, Figure 10-10. The uppermost part of the ramp shows no clear decline in mass balance; however, lower sections of the ramp surface have lowered, in common with other sites on the Antarctic Peninsula. The deposition of dust on the ramp originating from the runway may also be contributing to surface lowering, and mitigation measure are employed to reduce dust dispersal from the runway. Studies suggest that the ramp has been subject to episodes of advance and retreat over longer timescales.

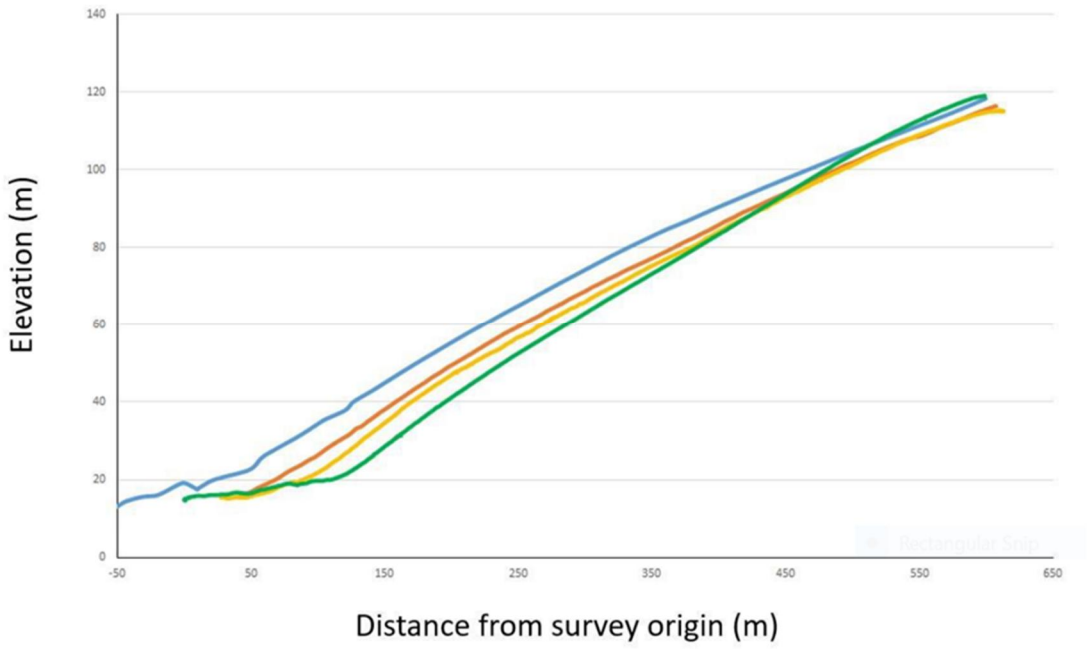

Figure 10-10 Elevation of the Rothera ice ramp between 1989 and 2021.

Line colours correspond to ramp profiles surveyed during different years: blue (1989), orange (1998), yellow (2008), green (2021). The base of the ice ramp has receded by > 100 metres in the past.

Several other areas of permanent ice exist on Rothera, notably to the south where ice cliffs have formed above the sea (to the east of the Wharf) but also crossing the southern boundary of ASPA No. 129.

10.8.10 Ice Streams

The Rutford Ice Stream is one of the large, fast-flowing glaciers that drain and deliver the ice melt water to the ocean. In 2023, ice-sounding airborne synthetic aperture radar depth profiles collected from the Recovery Ice Stream in 2016/17 and the Rutford Ice Stream 2019/20 were used to test the RGB-Doppler-Decomposition method[50] to establish the palaeoenvironmental condition of the ice streams to understand when the ice sheet last disappeared completely, how water and sediment underneath the ice accelerated the rate of melting into the oceans.

10.8.11 Permafrost

In February 2009, a new 30 m permafrost borehole was installed close to Rothera (67.57195°S 68.12068°W)[51]. The borehole is situated at 31 m ASL on a granodiorite knob with scattered lichen cover. Snow persistence is variable both spatially and temporally with snow free days per year ranging from 13 to more than 300, and maximum snow depths varying between 0.03 and 1.42 m. This variability is the main cause of high variability in ground surface temperatures, which ranged between -3.7 and -1.5 °C. The net effect of the snow cover is a cooling of the surface. The active layer thickness ranged between 0.76 and 1.40 m. Active layer thickness temporal variability was greater than reported at other sites at similar latitude in the Northern Hemisphere, or with the similar mean annual air temperature in Maritime Antarctica, because vegetation and a soil organic horizon are absent at the study site. Zero annual amplitude in temperature was observed at about 16 m depth, where the mean annual temperature was -3 °C. Permafrost thickness was calculated to range between 112 m and 157 m, depending on the heat flow values adopted. The presence of sub-sea permafrost cannot be excluded considering the depth of the shelf around Rothera and its glacial history.

[50] Arenas Pingarron, A., Brisbourne, A., Corr, H., Jordan, T., Robinson, C., Martin, C., Nicholls, K., & Smith, A. 2023. Ice-sounding airborne synthetic aperture radar depth profiles from Recovery Ice Stream 2016/17 and Rutford Ice Strem 2019/20 to test the RGB-Doppler-Decomposition method. (Version 1.0) [Data set]. NERC EDS UK Polar Data Centre. https://doi.org/10.5285/40c2f86b-1a02-4106-934a-42769682df66

[51] Guglielmin, M, Worland, RM, Baio, F. 2014. Permafrost and snow monitoring at Rothera Point (Adelaide Island, Maritime Antarctica): Implications for rock weathering in cryotic conditions. Geomorphology 225: 47–56.

10.8.12 Flood Risk

Tsunami risk is difficult to predict or mitigate against; however, the region lies within the influence of tectonic events around the Scotia Arc and may be subject to tsunami incidents at some points in the future. Nevertheless, the location of Rothera within Marguerite Bay on the east side of Adelaide Island, with the Antarctic Peninsula on the other side of Laubeuf Fjord, may afford some protection against the most severe impact of a tsunami.

Sea level rise is not expected to be sufficient over the anticipated lifespan of the wharf to present a significant threat and will be largely compensated for by on-going isostatic rebound in the region. Some local flood risk may be presented by the drainage of the freshwater pool located to the south of Rothera, should any alterations be made to the local topography during possible future construction work.

10.8.13 Noise and Vibration

Rothera is already an area subject to substantial levels of noise originating from aircraft using the gravel runway, large vehicles for cargo transfer, construction purposes and snow movement, and occasional use of sirens to signal aircraft landings or a station emergency. Many of the marine mammals hauled out around Rothera and the non-breeding and breeding skuas that congregate, particularly at the north end of the runway, appear to be habituated to these noises and show little or no observable sign of disturbance. Adélie penguins that may congregate on East Beach are subject to less noise originating from Rothera's main buildings and runway. Local noise / vibration monitoring has been undertaken during construction work for the wharf and the Discovery Building.

10.9 Protected Areas

Rothera is located within Antarctic Conservation Biogeographic Region (ACBR): No. 3 Northwest Antarctic Peninsula. ACBRs represent specific biological communities or conditions on ice-free ground. They work in concert with Environmental Domains. Rothera Point is represented by both *Environment B – Antarctic Peninsula mid-northern latitudes geologic* for the ice-free ground, and *Environment E – Antarctic Peninsula and Alexander Island main ice fields*[52], which includes ASPA 129, detailed below.

10.9.1 Antarctic Specially Protected Areas

The primary reason for the designation of ASPA No. 129 Rothera, Adelaide Island (Lat. 68°07'S, Long. 67°34'W), as an ASPA is to protect scientific values, and primarily that the area serves as a control area, against which the effects of human impact associated with the adjacent Rothera could be monitored in an Antarctic fellfield ecosystem, Figure 10-11. Rothera was originally designated in Recommendation XIII-8 (1985, SSSI No. 9) after a proposal by the United Kingdom.

The ASPA is unique in Antarctica as it is the only protected area currently designated solely for its value in the monitoring of human impact. The objective is to use the ASPA as a control area that has been relatively unaffected by direct human impact, in assessing the impact of activities undertaken at Rothera on the Antarctic environment. Monitoring studies undertaken by BAS began at Rothera in 1976. On-going environmental monitoring activities within the Area and Rothera include:

I. Assessment of heavy metal concentrations in lichens;
II. Measurement of hydrocarbon and heavy metal concentrations in gravel and soils; and
III. Survey of the breeding bird populations.

Nevertheless, the appropriateness of the ASPA as a control site for monitoring studies has been put into question due to the close proximity of the ASPA to Rothera's main buildings and infrastructure, the footprint of which has expanded in recent years. A management plan is in place for ASAP No. 129. Monitoring activities are now also being duplicated on Donnelly Island, within ASPA 177 Leonie Islands and southeast Adelaide Island, which was designated in 2021, Figure 10-11.

[52] https://oldwww.landcareresearch.co.nz/__data/assets/pdf_file/0015/32901/eda_v2_final_report.pdf

Contrary to earlier assessments, recent research has shown that the vegetation of Rothera is representative of the floristic diversity typical of vegetation communities of the north-western Antarctic Peninsula. Furthermore, Rothera, including ASPA 129, has some of the largest floristic richness and more complex vegetation within the wider geographical context of Marguerite Bay and Adelaide Island. As such, the vegetation on Rothera is of outstanding value.

Entry into the ASPA is strictly prohibited unless in accordance with a permit issued by the Foreign and Commonwealth Development Office (FCDO).

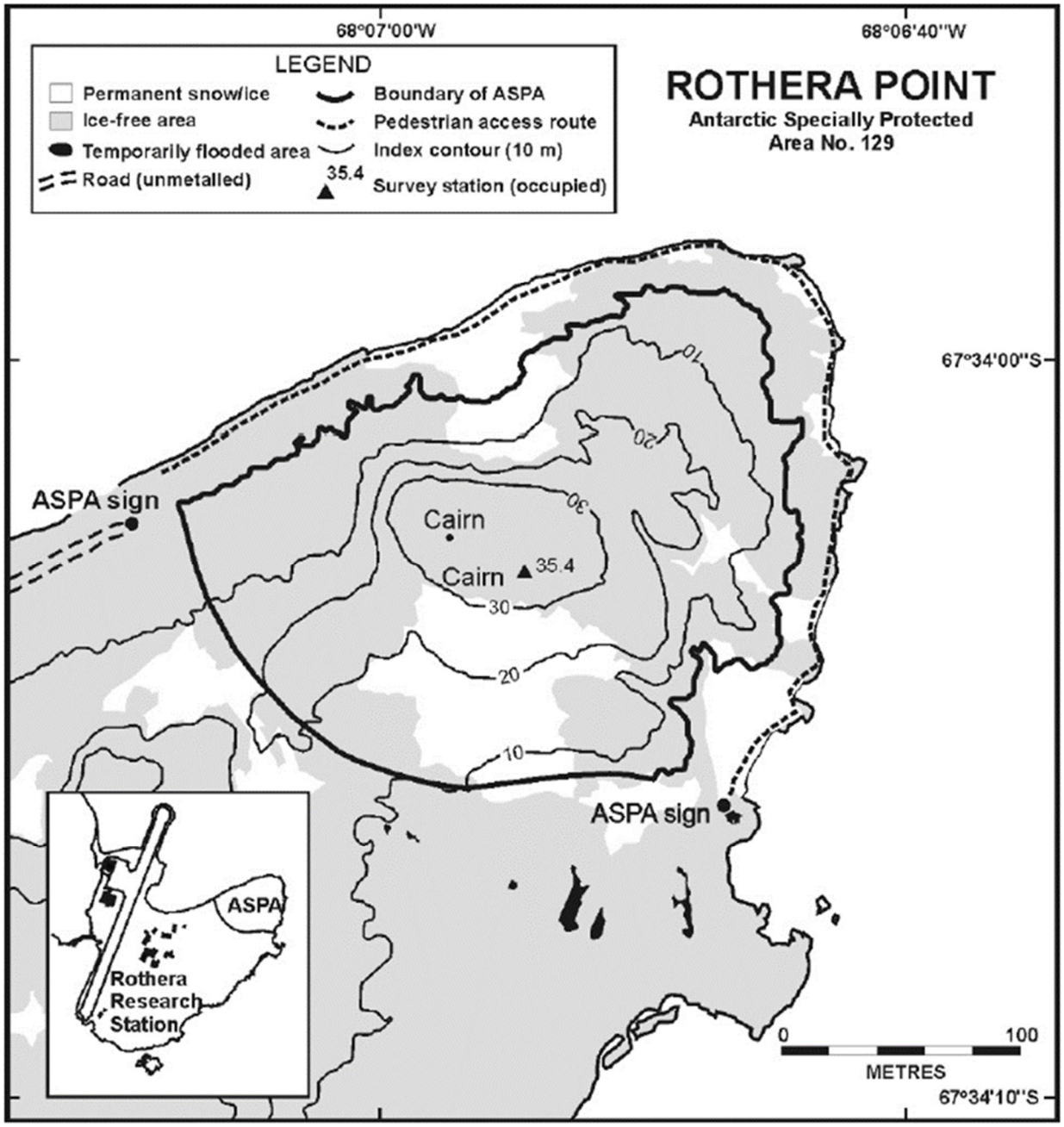

Figure 10-11 Map of ASPA No. 129 Rothera, Adelaide Island, BAS 2019

10.9.2 Important Bird and Biodiversity Area (IBA)

Although not formally recognised under the Antarctic Treaty System, BirdLife designated the areas around Ryder Bay an Important Bird and Biodiversity Area (IBA) in 2018 (AQ205). The IBA includes part of Rothera that includes East Beach, Figure 10-12. The IBA extends to the islands in Ryder Bay, many of areas of which are protected under the Antarctic Treaty System through designation of ASPA 177 Leonie Islands and southeast Adelaide Island, shown in part in the inset of Figure 10-12.

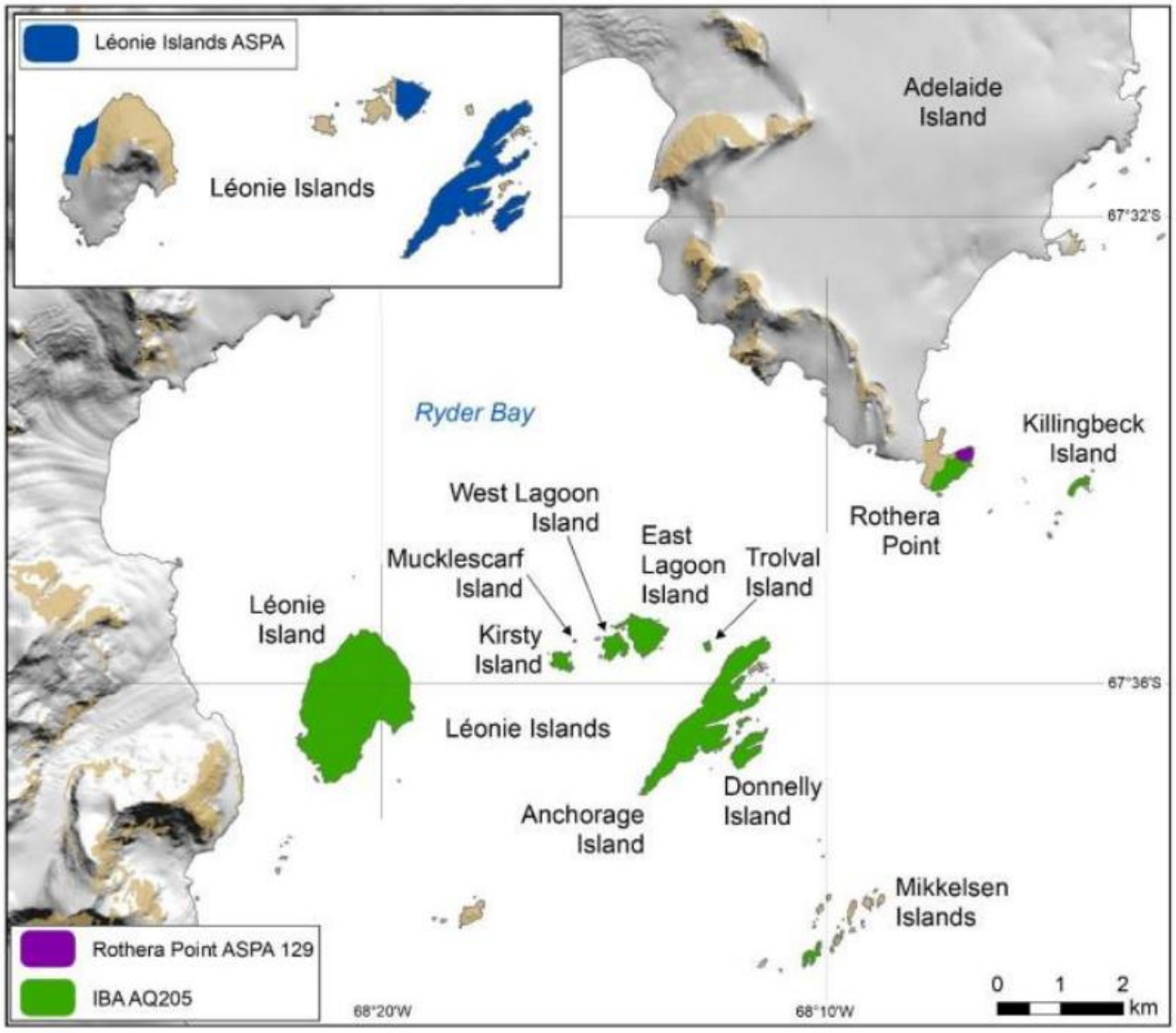

Figure 10-12 Map of the Ryder Bay area showing the extent of ASPA 129 Rothera (Purple), ASPA 177 Leonie Islands and south-east Adelaide Island (blue) and Important Bird and Biodiversity Areas (IBA) AQ205 (green)

10.10 Cultural Heritage

BAS has operated from Rothera since 1975. Whilst there are no formally designated Historic Sites and Monuments (HSMs) at Rothera, the site does have a rich cultural heritage which has developed over the years. Heritage is important to BAS and the wider UK Antarctic community. There is a monument point located to the south of Rothera towards the wharf.

10.11 Landscape, Visual and Aesthetic Value

Whilst there is not an internationally agreed definition of aesthetic value in Antarctica, it is generally characterised by the lack of visible evidence of human activity including permanent infrastructure. In addition, the wilderness value of a location in Antarctica is often related to a feeling of remoteness[53]. Recent research (2020) has attempted to quantify Antarctic wilderness, by analysing where there has been human activity over the last 200 years. Where no records of human activity exist, these are identified as inviolate wilderness areas and account for approximately 32% of the continent[54].

For over 40 years the British Antarctic Survey has concentrated its southern Antarctic Peninsula station infrastructure largely within the confines of the 0.4 km^2 area of Rothera. This concentration of activity within a small area means that there has not been an on-going expansion of Rothera's footprint (as observed at other Antarctic stations), not least because space for construction is limited. A result of this, evidence of human presence is visible from most areas of Rothera; however, the great majority of infrastructure has been constructed on the northwest side of the central rocky north-east to south-west trending ridge that dissects Rothera. Consequently, it is possible to experience a genuine wilderness experience when on East Beach and on the northern fringes of ASPA No. 129.

Indeed, it is common for Rothera personnel wanting to get away from busy station life to go for a 'walk round the Point', which involves walking around the northern fringes of the ASPA to East Beach and then up to the memorial cross before returning to the station. The benefit to the mental health of Rothera personnel cannot be overstated. With most of the infrastructure confined to the Point itself, views in almost every direction away from the Point show near pristine Antarctic scenery of outstanding wilderness and aesthetic value, Figure 10-13.

Figure 10-13 View From Rothera Across Marguerite Bay to Leonie Island, and the Princess Royal Range Beyond, the Wilderness and Aesthetic Values of Which are Protected Through ASPA 177 Leonie Islands and South-East Adelaide Island

[53] Tin T., and Summerson R, 2013. Growing human footprint, diminishing wilderness in Antarctica. International Journal of Wilderness 19 (3): 10– 13, 36.

[54] Leihy, R.I., Coetzee, B.W.T., Morgan, F. et al. Antarctica's wilderness fails to capture continent's biodiversity. Nature 583, 567–571 (2020). https://doi.org/10.1038/s41586-020-2506-3

10.12 Climate Change

Rothera has been subject to human activity for over 40 years and in that time some parts have been dramatically modified from their original state, while others remain relatively free of impacts. Coupled with this, climate variability has resulted in changes in marine, terrestrial and ice characteristics around Rothera with consequent impacts upon local marine and terrestrial ecosystems. Due to the high levels of uncertainty in modelled outputs in the polar regions, it is difficult to accurately predict climate change impacts at Rothera, however changes observed to date such as increased temperatures, give a strong indication of likely climate change impacts. On-going development of BAS' logistical capacity at Rothera will likely result in further modifications of the environment, with impacts likely to be minimised if constrained to areas of existing human activity and impact. Climate change impacts may be more difficult or impossible to mitigate, which may have substantial impacts on elements of the logistical capacity at Rothera. With the current scientific data available it is impossible to accurately predict the impacts of climate change on environments in the vicinity of Rothera. However, should climate warming occur then impacts upon Rothera may include:

- Melting and steepening of the ice ramp that joins Rothera to the rest of Adelaide Island;
- Increase in ice-free ground on Rothera, associated with the melting and shrinking of areas of permanent ice;
- Changes in bird population numbers linked to climate change effects on food sources and weather conditions during the breeding season;
- Seasonal changes in water availability for terrestrial communities leading to alterations in community structure and species distribution across Rothera;
- Changes in permafrost depth;
- Further changes in the intensity of iceberg scour of marine environments around Rothera, linked to changes in sea ice conditions that are, in turn, associated with changes in winds over the Peninsula;
- Changes in the presence of sea ice-dependant species around Rothera, as sea-ice become less reliable; and
- Increased likelihood of establishment of any non-native species introduced to Rothera.

10.13 Ocean Acidification

The oceans moderate the rate and severity of climate change as oceans absorb large quantities of anthropogenic carbon dioxide (CO_2) and this results in large-scale changes in seawater chemistry, which is known as anthropogenic ocean acidification[55]. To understand the ecosystem response to climate change, a 92-day lab-based experiment carried out on replicate macrofaunal mesocosms of Astarte crenata, *Ctenodiscus crispatus, Cistenides hyperborea* from the Western Barents Sea and *Aequiyoldia eightsi and Laternula elliptica* from Rothera, Antarctic Peninsula. The macrofauna were collected from the Western Barents Sea in the cove adjacent to Rothera[56]. The data identified that responses to warming and acidification vary between species and lead to a reduction in intra-specific variability in behavioural trait expression that adjusts the magnitude and direction of nutrient concentrations. The data also indicated that species behaviour is not predetermined but can be dependent on local variations in environmental history. Such changes in species behaviour may act as an early warning for impending ecological transitions associated with progressive climate forcing[57].

[55] Gattuso, J.P., Mach, K.J. and Morgan, G. 2013. Ocean acidification and its impacts: an expert survey. Climatic change, 117, pp.725-738.
[56] Williams, T.J., Reed, A.J., Peck, L.S., Godbold, J.A., & Solan, M. 2023. Measurements for a 92-day climate manipulation experiment on replicate macrofaunal mesocosms collected on the cruise JR18006 in the Western Barents Sea and at Rothera research station in 2019 (Version 1.0) [Data set]. NERC EDS UK Polar Data Centre. https://doi.org/10.5285/7adc7b14-abae-4ab9-b60b-b9b6e0e9f320
[57] Williams, T.J., Reed, A.J., Peck, L.S. et al. 2024. Ocean warming and acidification adjust inter- and intra-specific variability in the functional trait expression of polar invertebrates. Sci Rep 14, 14985. https://doi.org/10.1038/s41598-024-65808-5

10.14 Global Climatic and Ecological Impacts of Oceanographic Changes

Oceanographic changes in proximity to Antarctica have global climatic and ecological impacts due to the interrelated nature of the Earth System. As part of the Rothera Time Series (RaTS) programme of Sustained Observation focussed on crucial Earth System indicators in Antarctica, a data set for quasi-weekly, year-round oceanographic and ice measurements at the coastal Western Antarctic Peninsula from 1997 to 2018 has been collected[58]. A year-round dataset collected at Rothera, which is located adjacent to Ryder Bay, and embayment within Marguerite Bay, at 67°34′8″S, 68°7′29″W, on the eastern side of Adelaide Island at the west Antarctic Peninsula, Figure 10-14.

[58] Clarke, A., Meredith, M., Venables, H., Hendry, K., Peat, H., ten Hoopen, P., Brandon, M., Henley, S., Annett, A., Leng, M., Arrowsmith, C., Chapman, A., Beaumont, J., Piper, R., Miller, A., Mann, P., Rossetti, H., Massey, A., Souster, T., … Clement, A. 2022. Quasi-weekly, year-round oceanographic and ice measurements at the coastal Western Antarctic Peninsula from 1997 to 2018 (Version 1.0) [Data set]. NERC EDS UK Polar Data Centre. https://doi.org/10.5285/50acb5b7-5b42-44cd-a98e-790bd367f204

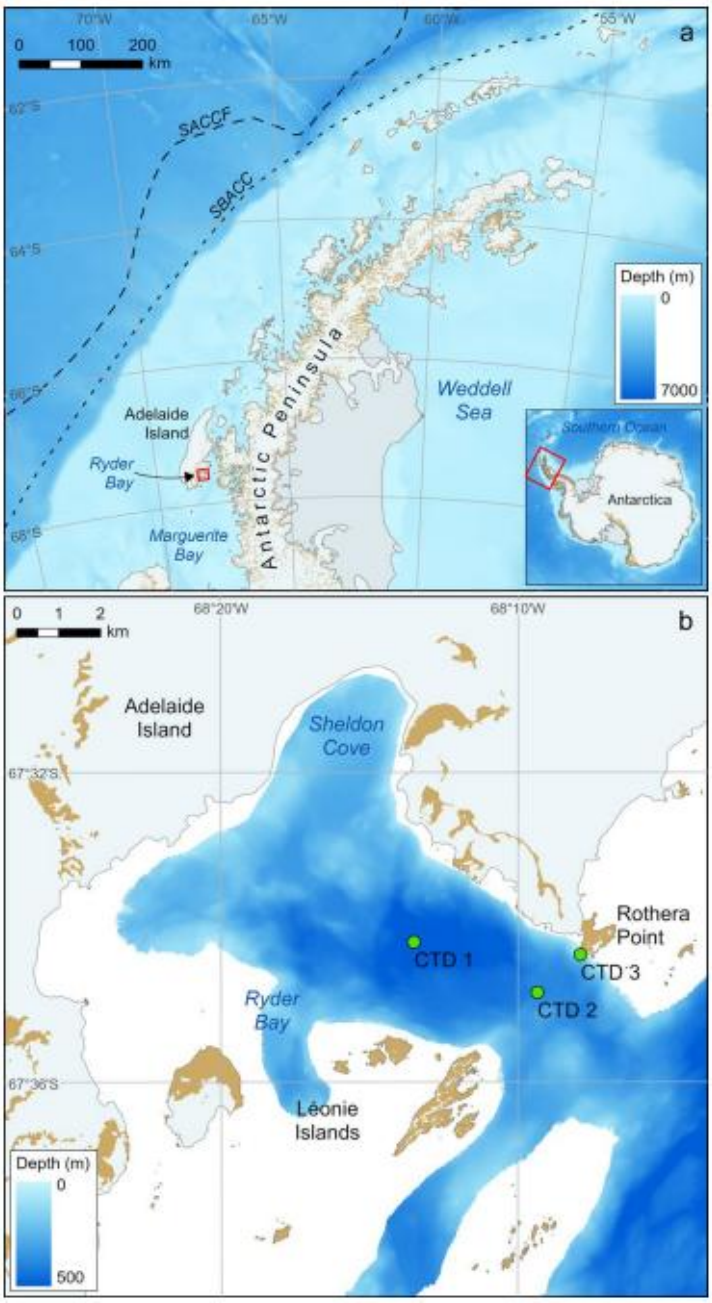

Figure 10-14 Sampling locations. (a) location of Ryder Bay within Marguerite Bay at the west Antarctic Peninsula, WAP; (b) sampling sites within Ryder Bay used in Rothera Time Series (CTD sites 1, 2, and 3 shown by green circles). SACCF=Southern Antarctic Circumpolar Current Front; SBACC=Southern Boundary of the Antarctic Circumpolar Current.[62]

The surveyed area has a relatively mild and maritime climate with temperatures above freezing during the summer and temperatures falling to -20°C during the winter, Figure 10-15. Sea ice forms in winter but is not always present or persistent, depending on variability in air temperature and wind strength and direction These factors combine to create significant variability through the time series on seasonal and interannual timescales. The deep waters on the Antarctic shelf are modified Circumpolar Deep Water (mCDW), which derives from the Circumpolar Deep Water that flows along the shelf break at the southern edge of the Antarctic Circumpolar Current (ACC). The data set identified that the water reaching Rothera is particularly strongly modified due to the route through narrow deep channels and sills blocking the flow creating localised mixing. The atmosphere has warmed strongly over the past several decades. The summertime surface ocean and deep ocean have warmed significantly since the middle of the last century, which has impacted glacial retreat[59].

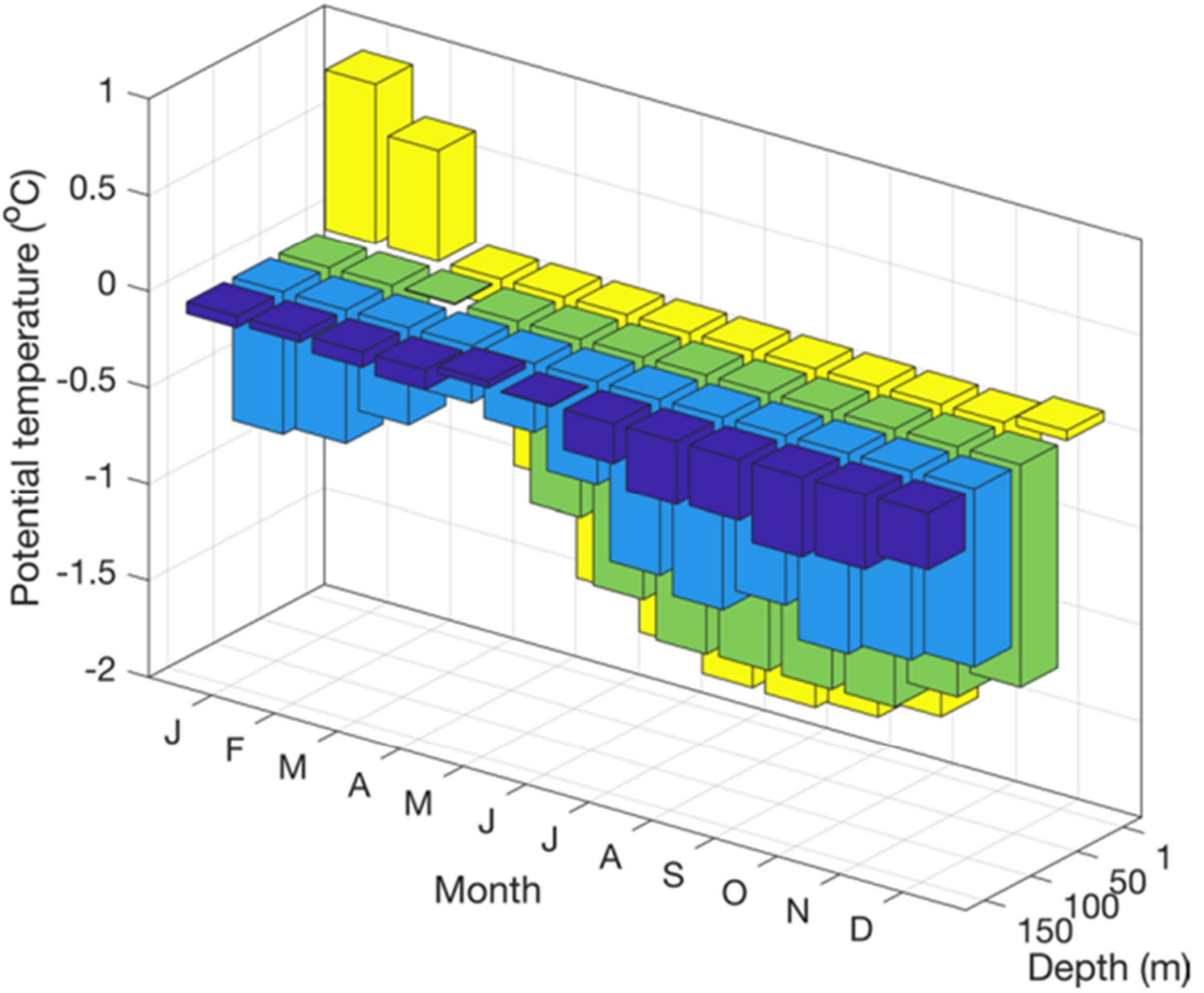

Figure 10-15 Seasonal climatology of potential temperature measurements at different depth levels (1, 50, 100, and 150 m)

[59] Venables, Hugh, Meredith, Michael P., Hendry, Katharine R., ten Hoopen, Petra, Peat, Helen, Chapman, Alice, Beaumont, Jennifer, Piper, Rayner, Miller, Andrew J., Mann, Paul, Rossetti, Helen, Massey, Ali, Souster, Terri, Reeves, Simon, Fenton, Mairi, Heiser, Sabrina, Pountney, Sam, Reed, Sarah, Waring, Zoë, Clark, Marlon, Bolton, Emma, Mathews, Ryan, London, Hollie, Clement, Alice, Stuart, Emma, Reichardt, Aurelia, Brandon, Mark, Leng, Melanie, Arrowsmith, Carol, Annett, Amber, Henley, Sian F., Clarke, Andrew. 2023. Sustained, year-round oceanographic measurements from Rothera Research Station, Antarctica, 1997-2017. Scientific Data, 10. https://doi.org/10.1038/s41597-023-02172-5.

11. ASSESSMENT OF THE ENVIRONMENTAL IMPACTS

11.1 Methodology

This chapter identifies the actual or potential impacts that could or will occur as a result of the proposed activities.

The environmental impact assessment has followed a four-step process involving:

- Identifying the proposed activities of the project;
- Identifying the environmental aspects – the way in which any of the proposed activities interact with the environment such as atmospheric emissions, dust, noise, fuel spills, waste, introduced non-native species etc;
- Identifying the environmental impact – the change in environmental value or resource as a result of the activity; and
- Assessing the significance of the identified impact – considering the spatial extent, duration, probability of occurrence and severity of the potential impact on the environment with reference to the three levels of significance identified by Article 8 (1) of the Protocol i.e., less than, no more than, or more than a minor or transitory impact.

The 'Previously Assessed Activities' listed in Section 3.3 that are planned for the 2024 – 2025 and 2025 – 2026 Seasons are not reassessed in Sections 11.3 to 11.21 of this IEE, but are assessed in Section 12 which details the assessment of cumulative impacts.

11.2 Proposed Activities

The nature, scale and duration of the proposed activities have been described in Sections 3 to 8. For the purposes of the assessment of potential impacts, these activities have been divided into categories based on the nature of the works. The activity categories and the activities each category includes for assessment in this IEE are summarised below, items in *italics* are previously assessed activities and not included further within the impact assessment stages until cumulative impacts are considered:

- Construction Activities;
  - Managing runway defects, including scarification [RUNSUR]
  - Trench excavation [RENEW, RUNSUR, RMP]
  - Trench backfilling with excavated and additional material [RENEW, RUNSUR, RMP]
  - Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP]
  - Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP]
  - Waterproofing flooded and / or frozen ducting and chambers [RUNSUR, RMP]
  - Water jetting of frozen ducting [RUNSUR, RMP];
  - Creation of non-engineered slipways [RUNSUR];
  - Processing, screening, and crushing of rock material [RUNSUR, RMP]
  - Transporting rock material [RUNSUR]
  - Ground clearance, levelling and/or compaction with a machine excavator or whacker plate/roller [RMP]
  - Ground clearance and levelling by hand [VLF]
  - Installation of new buildings by hand [VLF]
  - Filling of gabions and routing of cable [VLF]
  - Installation or re-routing of buried power / data cable [RENEW, RMP]
  - Building strip-out and deconstruction [RMP]
  - Installing mooring points [WHARF]

- SI Works (intrusive) and Condition Surveys (visual/non-intrusive);
  - Intrusive SI boreholes [HANGAR];
  - Visual / non-intrusive condition surveys of existing structures (including use of MEWP) [RENEW]; and

  - Hand-Digging and GPR Survey for East Mooring Point [WHARF]
- Monitoring Activities;
  - Runway friction and CBR testing [RUNSUR]; and
  - Runway surface degradation monitoring [RUNSUR]
- Support Activities;
  - Vehicle, Plant, and Equipment Operation;
  - Shipping Cargo to and from Rothera;
  - Storage of Cargo at Rothera;
  - Transport of Personnel to and from Rothera;
  - Provision of Accommodation, Power, Logistical and Domestic Services;
  - Site Set-Up and Presence of Personnel;
  - Fuel Management and Refuelling;
  - Flushing/Cleaning of LTHW Systems
  - Sterilisation of Potable Water System;
  - Transportation of Construction Materials and New Structures across Rothera [VLF];
  - Removal of Waste from Rothera via Commercial Vessel [RMP];
  - Stockpile Management;
  - Survey Control Point Installations; and
  - Crane Winterisation [RMP].

11.3 Environmental Aspects

The Environmental Aspects have been based on the ATS EIA Guidelines[10] that state:

An environmental aspect may involve an output or addition to the environment (e.g., emission of pollutants, noise or light, human presence, transfer of native or non-native species, direct contact with wildlife or vegetation, leak, or spill of hazardous substances etc.) or a removal from the environment, such as the use of lake water, collection of moss samples or removal of rocks.

Table 11-1 Environmental Aspects of the Proposed Activities

No	Activities	Environmental Aspects											
		Atmospheric Emissions	Noise and Vibration Emissions	Dust Emissions	Waste	Light (External)	Physical Presence and Use of Space	Physical/Mechanical Disturbance on Land	Fuel or Hazardous Substance Release	Non-Native Species Introductions	Disturbance to Native Flora and Fauna	Visual	Heritage
Construction Activities													
1	Managing runway defects, including scarification [RUNSUR]	✓	✓	✓		✓	✓	✓	✓		✓		
2	Trench excavation [RENEW, RUNSUR, RMP]	✓	✓	✓		✓	✓	✓	✓		✓	✓	
3	Trench backfilling with excavated and additional material [RENEW, RUNSUR, RMP]	✓	✓	✓		✓	✓	✓	✓		✓	✓	
4	Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP]	✓	✓	✓		✓	✓	✓	✓		✓	✓	
5	Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
6	Waterproofing flooded and / or frozen ducting and chambers [RUNSUR]	✓	✓	✓		✓	✓	✓	✓		✓		
7	Water jetting of frozen ducting [RUNSUR, RMP]	✓	✓		✓	✓	✓	✓	✓		✓		
8	Processing, screening, and crushing of rock material [RUNSUR, RMP]	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
9	Transporting rock material [RUNSUR]	✓	✓	✓		✓	✓	✓	✓		✓		

No	Activities	Environmental Aspects											
		Atmospheric Emissions	Noise and Vibration Emissions	Dust Emissions	Waste	Light (External)	Physical Presence and Use of Space	Physical/Mechanical Disturbance on Land	Fuel or Hazardous Substance Release	Non-Native Species Introductions	Disturbance to Native Flora and Fauna	Visual	Heritage
10	Ground clearance, levelling and/or compaction with a machine excavator or whacker plate / roller [RMP]	✓	✓	✓		✓	✓	✓	✓		✓	✓	
11	Ground clearance and levelling by hand [VLF]					✓	✓	✓			✓	✓	
12	Installation of new buildings by hand [VLF]		✓		✓	✓	✓	✓			✓	✓	
13	Filling of gabions and routing of cable [VLF]		✓			✓	✓	✓			✓	✓	
14	Installation or re-routing of buried power / data cable [RENEW, RMP]	✓	✓	✓		✓	✓	✓	✓		✓	✓	
15	Building strip-out and deconstruction [RMP]	✓	✓	✓	✓		✓	✓	✓		✓	✓	
SI Works (Intrusive) and Condition Surveys (Visual/Non-Intrusive)													
16	Visual / non-intrusive condition surveys of existing structures (including use of MEWP) [RENEW]	✓	✓				✓		✓		✓		
17	Hand-Digging and GPR Survey for East Mooring Point [WHARF]						✓	✓			✓	✓	
Monitoring Activities													
18	Runway surface degradation monitoring [RUNSUR]					✓	✓						

No	Activities	Environmental Aspects											
		Atmospheric Emissions	Noise and Vibration Emissions	Dust Emissions	Waste	Light (External)	Physical Presence and Use of Space	Physical/Mechanical Disturbance on Land	Fuel or Hazardous Substance Release	Non-Native Species Introductions	Disturbance to Native Flora and Fauna	Visual	Heritage
Support Activities													
19	Vehicle, Plant and Equipment Operation	✓	✓	✓	✓	✓	✓	✓	✓		✓		
20	Shipping Cargo to and from Rothera	✓	✓	✓	✓	✓	✓		✓	✓	✓	✓	
21	Storage of Cargo at Rothera						✓	✓	✓	✓		✓	
22	Transport of Personnel to and from Rothera	✓	✓	✓	✓	✓	✓		✓	✓	✓		
23	Provision of Accommodation, Power, Logistical and Domestic Services	✓	✓		✓	✓	✓	✓	✓		✓	✓	
24	Site Set-Up and Presence of Personnel	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		
25	Fuel Management and Refuelling	✓	✓				✓		✓		✓		
26	Flushing/Cleaning of LTHW Systems		✓		✓		✓		✓		✓	✓	
27	Sterilisation of Potable Water [RMP]				✓				✓		✓		
28	Transportation of Construction Materials and New Structures across Rothera [VLF]	✓	✓	✓		✓	✓	✓	✓		✓		
29	Removal of Waste from Rothera via Commercial Vessel [RMP]	✓	✓	✓	✓	✓	✓		✓		✓		
30	Survey Control Point Installations		✓	✓			✓	✓			✓	✓	
31	Crane Winterisation [RMP]	✓	✓	✓	✓	✓	✓	✓	✓		✓		

11.4 Identification of Environmental Impacts and Mitigation Measures

For the below section, activities in Table 11-1 Environmental Aspects of the Proposed Activities are referenced in the format (No. XX)

This section identifies the potential environmental impacts of the project on the environmental aspects identified within Table 11-1. Impacts are any changes in environmental value or resource that will or may occur as a result of the identified activities listed below.

Each impact has been identified as either direct, indirect, cumulative, or unavoidable, and these are defined as follows:

- A direct impact is a change in environmental value or resource that results from direct cause effect consequences of interactions between the exposed environment and the activity (e.g. decrease of a limpet population due to an oil spill, or a decrease of a freshwater invertebrate population due to lake water removal);
- An indirect impact is a change in environmental value or resource that results from interactions between the environment and other impacts - direct or indirect (e.g., alteration in gull population due to a decrease in limpet population which in turn was caused by an oil spill);
- A cumulative impact is the combined impact of past, present, and reasonably foreseeable activities. These activities may occur over time and space and can be additive or interactive/synergistic. (e.g., decrease of limpet population due to the combined effect of oil discharges by base and ship operations); and
- An unavoidable impact is an impact for which no further mitigation is possible. For example, it may be possible to reduce the area from which the proposed new infrastructure will be visible, but it is unavoidable that the infrastructure will be visible over some area.

The following sections are considered to present the worst-case assessment of potential effects that could arise as a result of the proposed activities on the environmental aspects at Rothera, without the consideration of any mitigation or monitoring measures. Impacts have been grouped by environmental aspect and presented for each type of activity proposed to be undertaken as part of this IEE (e.g., construction activities, SI, condition surveys, monitoring activities and support activities). Where beneficial to aid the assessment, the activity numbers presented in Table 11-1 are used to demonstrate activity-specific impacts.

Where relevant and available, mitigation and/or monitoring activities have been suggested after each impact, which allows for an assessment of the residual impacts once mitigation measures have been considered according to the significance criteria as outlined in Table 11-2 allowing for residual impacts to be assessed. A full monitoring plan is included in Section 13.

11.5 Atmospheric Emissions Impacts

11.5.1 Construction Activities

Atmospheric emissions associated with construction activities through the use of vehicles and machinery are considered to cause a direct and cumulative contribution to global atmospheric pollution and heavy metal and particulate fallout locally. The extent of fuel usage will vary depending on the nature of the activity.

While atmospheric emissions are recognised to contribute to the global atmospheric system, the point source of atmospheric emissions associated with the proposed construction activities are considered to be restricted to the construction activities taking place throughout the 2024-2025 and 2025-2026 Seasons and will not be a continuous emission activity. The activities will be temporary in duration during the programme of works as outlined within this IEE, although are recognised to span two seasons collectively.

11.5.2 SI and Condition Surveys

Atmospheric emissions are associated with the Condition Survey activity (No. 16) through the use of vehicles and machinery, namely the MEWP, are considered to cause a minor direct and cumulative contribution to global atmospheric pollution.

While atmospheric emissions are recognised to contribute to the global atmospheric system, the point source of atmospheric emissions associated with this activity is considered to be low in duration and significance. This activity is considered to require one week to complete and is of low duration within either one of the 2024-2025 or 2025-2026 Seasons (not both) and will not be a continuous emission activity.

11.5.3 Monitoring Activities

There are no potential atmospheric emission impacts associated with the proposed Monitoring activities.

11.5.4 Support Activities

Atmospheric emissions associated with support activities in particular the transport of personnel and cargo to the site during the 2024–2025 and 2025–2026 Seasons are considered to cause a direct and cumulative contribution to global atmospheric pollution and heavy metal and particulate fallout locally. The extent of fuel usage will vary depending on the nature of the activity.

The remote location of Rothera and the challenge in accessing this location results in the atmospheric emissions associated with the support activities and are largely unavoidable. An increase in personnel or rotations of personnel required at Rothera will therefore result in an increase in unavoidable atmospheric emissions as a result of an increase in the number of flights during the 2024–2025 and 2025–2026 Seasons. No alternative means of transport are available that would reduce emissions. Support activities during the 2024–2025 and 2025–2026 Seasons will be undertaken for the required duration of the presence of personnel at Rothera (during the austral summers) as outlined within this IEE.

The BAS Operations Team are constantly innovating to minimise the BAS contribution to climate change through the routing of the SDA. The route of the SDA is mapped and monitored and from this data the team propose the most efficient route for the SDA in order to minimise trips, emissions, and fuel use. Therefore, the route optioneering undertaken by the BAS Operations Team ensures the most efficient transportation of personnel, to minimise global atmospheric emissions impacts as far as reasonably practicable.

Further mitigation for atmospheric emissions is available which is discussed in more detail within Table 11-4 and Section 13, but it should be noted that this will not completely eliminate the long-term impacts of atmospheric emissions.

11.6 Noise Emissions and Vibration Impacts

11.6.1 Construction Activities

Noise emissions and vibration impacts associated with construction activities are considered to cause a direct and cumulative noise and vibration impacts to local fauna, potentially resulting in avoidance or stress behaviour, injury and / or nest abandonment. The extent of noise and vibration generated will vary depending on the nature of the activity.

The source of noise and vibration emissions associated with the proposed construction activities are considered to be restricted to the periods when these activities take place throughout the 2024-2025 and 2025-2026 Seasons and will not be a continuous emission activity. The activities will be temporary in duration during the programme of works as outlined within this IEE, although they are recognised to span two seasons collectively. For the purposes of assessment, it has been assumed that the proposed activities are occurring concurrently to allow the assessment of potential risks and impacts to sensitive receptors in proximity of this location.

This assumption has been taken as the worst-case scenario for environmental assessment purposes and is not intended to reflect the exact programme for the proposed construction activities. Resource and equipment constraints are considered likely to manage the effects associated with concurrent noise and vibration generation at Rothera.

The proposed construction activities are being undertaken at various locations throughout Rothera, with sensitive ecological receptors present. The latest data on skua nest locations, Figure 10-1 Environmental Constraints at Rothera, suggests that the RMP activities are in closest proximity to nests. The active skua nests are located within the ASPA, IBA, and to the southwest of the ASPA. The nearest active skua nests are located in proximity to the Moss Patch and within operational hazard zones to the east of the buildings in proximity to the exposed rock faces, as shown in Figure 10-1.

A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy equipment such as the use of power tools and large machinery, and consideration given to the impact on wildlife. Animals on land (except nesting birds) will be given the opportunity to move away from the noise source before it reaches its highest level. At this point, the equipment may be used continuously.

The lack of research on the effects of vibration on animals means that no specific limit of vibration can be set for animal receptors, although data is available for the effects of vibration on humans and these limits are applied to manage effects to wildlife. Measurements of human exposure to vibration expressed as VDVs combine the magnitude of vibration and the time for which it occurs and are measured in $ms^{-1.75}$. Guidance on how vibration is perceived by humans in residential buildings, offices, and workshops and the effects of exposure to vibration have been used to inform the acceptable limits the for the site. Noise and vibration monitoring arrangements are set out in further detail in Section 13.2, with suitable vibration limits adopted at Rothera presented in Figure 13-1 Guideline limits for vibration velocity with respect to vibration.

Noise and vibration will be monitored to ensure levels do not significantly impact upon local wildlife. If agreed noise and/or vibration levels are exceeded, construction works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening.

11.6.2 SI and Condition Surveys

Noise and vibration emissions are associated with the Condition Surveys (No. 16) through the use of vehicles and machinery, namely the MEWP, and may cause a minor direct and cumulative noise and vibration impact, potentially resulting in avoidance or stress behaviour, injury and / or nest abandonment.

The source of noise and vibration emissions associated with this activity is considered to be low in significance. This activity is considered to require one week to complete with one MEWP in operation and is of low duration within either one of the 2024-2025 or 2025-2026 Seasons (not both) and will not be a continuous emission activity.

Typically for SI and condition survey activities, the key receptor for noise and vibration emissions is considered to be skua nests. The latest skua nest data, Figure 10-1 Environmental Constraints at Rothera, suggests that most of the known active skua nests are located sufficient distance away from the activity location. The closest skua nest is approximately 60 m east of NBH, one of the buildings due to be surveyed.

11.6.3 Monitoring Activities

There are no potential noise emissions and vibration impacts associated with the proposed Monitoring Activities.

11.6.4 Support Activities

Noise and vibration emissions associated with several support activities during the 2024 – 2025 and 2025 – 2026 Seasons are considered to cause direct and cumulative noise impacts to local fauna, potentially resulting in avoidance or stress behaviour, injury and / or nest abandonment. The extent of noise and vibration generated will vary depending on the nature of the activity.

The remote location of Rothera and the challenge in accessing this location results in largely unavoidable noise emissions associated with support activities to transport personnel and cargo to Rothera. Although these are not considered to significantly differ to those experienced in previous seasons, it should be noted that an increased number of construction personnel attending Rothera compared to previous seasons will increase the rotations and, therefore, increase the number of flights. However, these activities, such as SDA arrivals, aircraft landings on the runway, site setup and presence of personnel on site occur frequently and continuously throughout the year and are highly managed to ensure impacts to the local environment are minimised.

Wildlife is considered to be habituated to the noise emissions associated with the support activities that occur at Rothera, as demonstrated through the continued presence of active skua nests and wildlife present on and around the site. Support activities during the 2024 – 2025 and 2025 – 2026 Seasons will be undertaken for the required duration of the presence of personnel at Rothera (during the austral summers) as outlined within this IEE.

The installation of new survey control points (No. 30) has been included as an activity that could potentially incur noise and vibration impacts. The worst-case option for the control points is to instal one point behind the hangar, requiring the use of a concrete mixer to provide up to 30 kg concrete as a means of securing a steel pin which would act as the control point (Section 5.7). It should be noted, however, that potential noise and vibration impacts would likely only occur at the location behind the hangar, in proximity to former skua nests, while the six locations at the edge of the runway would be unlikely to result in noise and vibration impacts on local wildlife due to the non-intrusive nature of the installations at these locations.

Mitigation and monitoring for noise and vibration emissions is available, which is discussed in more detail within Table 11-4 and Section 13, and should be read in conjunction with the mitigation measures recommended for disturbance to native flora and fauna.

11.7 Dust Emission Impacts

11.7.1 Construction Activities

Dust emissions associated with construction works through activities such as the disturbance of ground, excavation and rock processing/crushing are considered to cause direct and cumulative effects to local flora through smothering/direct contact to vegetation due to dust deposition, and to local fauna through inhalation of dust. Dust deposition on areas of adjacent ice could decrease albedo and increase rates of ice melt at these locations. The extent of dust generation will vary depending on the nature of the activity and the weather conditions at the time of the activity.

The source of dust associated with the proposed construction activities are considered to be restricted to the 2024-2025 and 2025-2026 Seasons and will not be a continuous emission. The activities will be temporary in duration during the programme of works as outlined within this IEE, although are recognised to span two seasons collectively. For the purposes of assessment, it has been assumed that the proposed activities are occurring concurrently to allow the assessment of potential risks and impacts to sensitive receptors in proximity of this location.

This assumption has been taken as the worst-case scenario for environmental assessment purposes and is not intended to reflect the exact programme for the proposed construction activities. Resource and equipment constraints are considered likely to manage the effects associated with dust generation at Rothera.

The most sensitive receptors to dust emissions are the ice ramp, west of the runway, where solar monitoring enabling works, survey control point installation and stockpile material movement will take place, and the moss patch, which is to the east of several RMP activities.

11.7.2 SI and Condition Surveys

There are no potential dust emission impacts associated with the proposed SI and Condition Survey Activities.

11.7.3 Monitoring Activities

There are no potential dust emission impacts associated with the proposed Monitoring Activities.

11.7.4 Support Activities

The dust emissions associated with several support activities during the 2024-2025 and 2025-2026 Seasons are considered to cause direct and cumulative effects to local flora through smothering/direct contact to vegetation due to dust deposition and to local fauna through inhalation of dust. Dust deposition on areas of adjacent ice could decrease albedo and increase rates of ice melt at these locations. The extent of dust generation will vary depending on the nature of the activity and the weather conditions at the time of the activity.

The remote location of Rothera and the challenges associated with accessing this location results in largely unavoidable dust emissions associated with the use of the runway to transport personnel and equipment to Rothera. These are not considered to significantly differ to those experienced in previous seasons, but it should be noted that an increased number of construction personnel attending Rothera compared to previous seasons will increase the rotations and, therefore, could increase the number of flights. However, as aircraft landings on the runway occur frequently and continuously throughout the year, these are highly managed to ensure impacts to the local environment are minimised, along with regular runway maintenance and monitoring.

There may also be dust impacts caused by potential cement mixing and deposition to facilitate the worst-case survey control point installation option, though this would be a single, short-term occurrence.

It must be noted that while the construction activities are temporary, dust deposition can last beyond the season, highlighting the importance of a long-term monitoring plan at Rothera.

Mitigation and monitoring for dust emissions generated is available which is discussed in more detail within Table 11-4 and Section 13.

11.8 Waste Impacts

11.8.1 Construction Activities

Waste generation associated with construction activities are considered to cause direct and cumulative impacts on UK landfill capacity as a result of the increased quantities of waste required to be removed from Rothera and sent to landfill sites in the UK. Indirect impacts would arise from waste being transported from Rothera back to the UK resulting in increased carbon emissions being released into the atmosphere and an increased risk of waste being released into the local environment which could result in indirect impacts on the local marine and terrestrial environment which could pose a hazard to local wildlife if ingested.

The sources of waste and use of materials and resources associated with the proposed construction activities will be restricted to the 2024-2025 and 2025-2026 Seasons. All works will adhere to the relevant SWMP, Appendix 1. These waste generating activities will be temporary in duration during the programme of works as outlined within this IEE, although are recognised to span two seasons collectively.

11.8.2 SI and Condition Surveys

There are no potential waste impacts associated with the proposed SI and Condition Survey Activities.

11.8.3 Monitoring Activities

There are no potential waste impacts associated with the proposed Monitoring Activities.

11.8.4 Support Activities

The waste generation associated with support activities during the 2024-2025 and 2025-2026 Seasons is considered to cause direct and cumulative impacts on UK landfill capacity as a result of the increased quantities of waste that will be required to be removed from Rothera and sent to landfill sites in the UK. Indirect impacts would arise from waste being transported from Rothera back to the UK resulting in increased carbon emissions being released into the atmosphere and an increased risk of waste being released into the local environment which could result in indirect impacts on the local marine and terrestrial environment which could pose a hazard to local wildlife if ingested.

Support activity waste such as sewage and grey water production through the presence of AIMP construction personnel throughout the more recent Seasons at Rothera have led to a greater volume of wastewater discharged into the marine environment, which could contribute to local marine pollution. Support activity waste also applies to the use of vehicles, plant, and equipment, through the use of discarded components, such as oil, fuel, tyres, filters, and brakes. Although, the nature of these support activities is such that the waste associated is not considered to significantly differ to previous seasons.

Mitigation and monitoring for waste generated is available which is discussed in more detail within Table 11-4 and Section 13.

11.9 Light (External) Impacts

11.9.1 Construction Activities

External light emissions associated with the proposed construction works through the use of artificial light while working in low light conditions are considered to cause direct effects to local fauna, potentially resulting in disturbance, avoidance, or stress behaviour. There is also the potential for external lighting to cause disorientation to birds while flying resulting in injury or mortality due to strikes with buildings or equipment. The extent of light impacts (intensity and/or duration) will vary depending on local weather conditions and resulting visibility.

The source of external light emission associated with the proposed construction activities are considered to be restricted to the periods when these activities taking place throughout the 2024-2025 and 2025-2026 Seasons and will not be a continuous emission activity. It is assumed that task-based artificial light may be required in low light conditions or to increase visibility when required for all construction activities to ensure staff safety and visibility on site while working.

11.9.2 SI and Condition Surveys

There are no potential external light emissions impacts associated with the proposed SI and Condition Survey activities.

11.9.3 Monitoring Activities

External light emissions are associated with the monitoring activity proposed (No. 18) through the use of artificial light while working in low light conditions are considered to cause direct and cumulative effects to local fauna, potentially resulting in disturbance, avoidance, or stress behaviour. There is also the potential for external lighting to cause disorientation to birds while flying resulting in injury or mortality due to strikes with buildings or equipment. The extent of light impacts will vary depending on local weather conditions and resulting visibility.

11.9.4 Support Activities

The light (external) emissions associated with support activities, such as the operation of vehicles, and plant; provision of accommodation, power, and domestic services; and the use of the runway are considered to cause direct effects to local fauna, potentially resulting in disturbance, avoidance, or stress behaviour. There is also the potential for external lighting to cause disorientation to birds while flying resulting in injury or mortality due to strikes with buildings or equipment. Light impacts associated with support are considered critical to safe operations at Rothera.

The external light impacts associated with the proposed support activities for the 2024 – 2025 and 2025 – 2026 Seasons will be temporary in duration during the programme of works as outlined within this IEE, although are recognised to span two seasons collectively.

Mitigation and monitoring for external light emissions is available which is discussed in more detail within Table 11-4 and Section 13.

11.10 Physical Presence and Use of Space Impacts

11.10.1 Construction Activities

Impacts associated with the physical presence and use of space by all of the proposed construction activities at Rothera are considered to cause a direct, indirect, and cumulative impact to all ongoing operations and potentially the working relationship between the BAS and BAM Staff. For example, should construction activities conflict with research activities or damage science equipment.

The duration of the impacts relating to physical presence and use of space are restricted to the construction activities taking place throughout the 2024-2025 and 2025-2026 Seasons and will not be a continuous activity or pressure, although are recognised to span two seasons collectively.

While the physical presence and use of space impacts associated with the proposed construction activities have been assessed for both the 2024 – 2025 and 2025 – 2026 Seasons, as detailed within the programme of works within this IEE, these works are not considered to result in a significantly greater use of space at Rothera, when compared to construction presence required for previous seasons. In addition, there is a limit to the number of personnel (both science and construction staff) able to travel to Rothera in any given Season, and construction activities are planned with resource availability in mind.

11.10.2 SI and Condition Surveys

Impacts associated with the physical presence and use of space associated with the SI and Condition Survey activities have the potential to cause an indirect impact to ongoing operations in the vicinity and potentially the working relationship between the BAS and BAM Staff. For example, should SI and survey activities conflict with research activities or damage science equipment, or the presence of the visual building condition surveys disrupt day-to-day station operations.

The location of the proposed SI and Condition Surveys are not considered to significantly interfere with ongoing activities. While the physical presence and use of space impacts associated with the proposed construction activities have been assessed for both the 2024 – 2025 and 2025 – 2026 Seasons, as detailed within the programme of works within this IEE, these works are not considered to result in a significantly greater use of space at Rothera, when compared to construction presence required for previous seasons. In addition, there is a limit to the number of personnel (both science and construction staff) that are able to travel to Rothera in any given Season, and construction activities are planned with resource availability in mind.

11.10.3 Monitoring Activities

Impacts associated with the physical presence and use of space by all of the proposed Monitoring Activities at Rothera are considered to cause an indirect impact to all ongoing operations and potentially the working relationship between the BAS and BAM Staff. For example, should monitoring activities conflict with runway operations, research activities or other day-to-day station operations.

While the physical presence and use of space impacts associated with the proposed monitoring activities have been assessed for both the 2024 – 2025 and 2025 – 2026 Seasons, as detailed within the programme of works within this IEE, these works are not considered to result in a significantly greater use of space at Rothera, when compared to previous seasons. In addition, there is a limit to the number of personnel (both science and construction staff) able to travel to Rothera in any given Season, and construction activities are planned with resource availability in mind.

11.10.4 Support Activities

Impacts associated with the physical presence and use of space by all support activities at Rothera are considered to cause a direct, indirect, and cumulative impact to all ongoing operations and potentially the working relationship between the BAS and BAM Staff.

The impacts associated with physical presence and use of space by support activities are considered to be a vital function for operations at Rothera. While the proposed support activities for the 2024 – 2025 and 2025 – 2026 Seasons have been assessed for the programme of works as outlined within this IEE, these support activities are required every season in order for operations to continue at Rothera.

Mitigation for the effects of physical presence and use of space is available which is discussed in more detail within Table 11-4 and Section 13, but it should be noted that this will not completely eliminate the effect.

11.11 Physical or Mechanical Disturbance on Land Impacts

11.11.1 Construction Activities

Impacts associated with physical or mechanical disturbance on land associated with some construction activities, through below-ground excavation are considered to cause direct and cumulative impacts to ground disturbance at Rothera. Disturbance on land could also be considered to contribute to the deterioration of existing road infrastructure at Rothera.

The duration of the impacts relating to physical and mechanical disturbance are restricted to the specific construction activities that require intrusive works taking place throughout the 2024 – 2025 and 2025 – 2026 Seasons. Although the duration is not considered to be the biggest driver of significance when compared to the scale and methodology for excavation and the location of the intrusive activity. All construction activities are within previously disturbed ground and therefore physical and/or mechanical disturbance is not anticipated for previously undisturbed (or 'natural') surfaces. Table 11-4 presents the worst-case risk rating however it is acknowledged that the effects associated with activities undertaken by hand (No. 11 and No. 12) will have a negligible effect in relation to mechanical disturbance when compared to activities using plant.

11.11.2 SI and Condition Surveys

Impacts associated with physical or mechanical disturbance on land are associated with the East Mooring Point SI activity, through intrusive investigation (confined to snow and ice) are considered to cause direct and cumulative impacts to the overlying surface, (categorised here for consistency as ground disturbance) at Rothera.

It should be noted that the East Mooring Point SI activity is an exception. While the East Mooring Point SI is located in previously undisturbed or minimally disturbed land, the digging will be done by hand with shovels or picks and will only excavate the overlaying snow and ice and will not penetrate the rock surface. The use of GPR allows geological data to be obtained through non-intrusive methods. This activity is considered to be essential to inform future enabling works at the East Mooring Point site through an understanding of the geological context below the snow and ice. Table 11-4 presents the worst-case risk rating for this activity (No. 17) however it is acknowledged that the GPR activity will have a negligible effect in relation to mechanical disturbance.

11.11.3 Monitoring Activities

There are no potential physical or mechanical disturbance on land impacts associated with the proposed Monitoring Activities.

11.11.4 Support Activities

Impacts associated with physical or mechanical disturbance on land by support activities are considered to cause a direct and cumulative contribution to ground disturbance at Rothera as a result of daily site operations, storage of cargo and vehicle transportation around site.

The impacts associated with physical or mechanical disturbance on land from support activities are considered to be a vital function for operations at Rothera. While the proposed support activities for the 2024 – 2025 and 2025 – 2026 Seasons have been assessed for the programme of works as outlined within this IEE, the majority of these support activities are required each and every season in order for operations to continue at Rothera. A notable exception within this IEE is the transportation of construction materials across Rothera (No. 28), especially for the VLF Hunt which will be transporting material outside the main footprint of Rothera Station.

All contractors will be briefed on the locations of environmentally sensitive areas (Figure 10-1 Environmental Constraints at Rothera which are close to proposed activities, and control measures (such as demarcation) to avoid causing physical disturbance to these areas, or entrance into the ASPA when transporting material for the new VLF hut (No. 28). Consideration of disturbance is also needed when working near the Ice Ramp, as it is an 'Operational Hazard Zone', and may be interacted with when installing the survey control point behind the hangar (No. 30).

Mitigation for the effects of physical and mechanical disturbance on land is available which is discussed in more detail within Table 11-4 and Section 13, but it should be noted that this will not completely eliminate the effect.

11.12 Fuel or Hazardous Substance Release Impact

11.12.1 Construction Activities

Impacts associated with fuel or hazardous substance release from the majority of construction activities have the potential to cause direct, indirect, and cumulative impacts on the local environment. A pollution incident has the potential to result in the mortality of flora and fauna, and secondary contamination if animals or birds ingest any contaminated material. Similarly, hazardous waste would be generated through the use of absorbents to clean up a spill. The extent of the impact of a fuel spill will vary depending on the nature of the fuel and the scale and location of the incident.

Direct impacts associated with fuel or hazardous substance release are anticipated for the proposed construction activities, which would have a temporary duration of the 2024 – 2025 and 2025 – 2026 Seasons. Whereas indirect and/or cumulative effects could have the potential to result in longer term negative effects on the terrestrial environment, such as causing mortality to wildlife and associated population impacts. Previous occurrences of oil and fuel spills are recorded in BAM Environment Forms: EF08 (Environmental Incident / Near Miss Notifications) indicate that these have all been localised, concise spillages, which were quickly contained and captured in catch trays and effectively cleared using appropriate spill kits. Therefore, long-term impacts are considered to be unlikely, but not impossible given the rocky nature of the site making full capture of hazardous substance difficult.

11.12.2 SI and Condition Surveys

Impacts associated with fuel or hazardous substance release from the visual condition surveys (No. 15), through the use of a MEWP, have the potential to cause direct and indirect impacts on the local environment. A pollution incident has the potential to result in the mortality of flora and fauna, and secondary contamination if animals or birds ingest any contaminated material. Similarly, hazardous waste would be generated through the use of absorbents to clean up a spill. The extent of the impact of a fuel spill will vary depending on the nature of the fuel and the scale and location of the incident – the potential risk of this activity is considered to be very low.

Direct impacts associated with fuel or hazardous substance release for the Condition Surveys would have a temporary duration of one week during the 2024 – 2025 Season. Therefore, the impacts associated with this activity are considered to be negligible when compared to construction activities. Table 11-4 presents the worst-case risk rating however it is acknowledged that the effects associated with activity No. 15 will be negligible in relation to fuel and hazardous substance release when compared to construction activities.

11.12.3 Monitoring Activities

There are no potential fuel or hazardous substance release impacts associated with the proposed Monitoring Activities.

11.12.4 Support Activities

Impacts associated with fuel or hazardous substance release due to support activities have the potential to cause a direct, indirect, and cumulative effects on the local environment. A pollution incident has the potential to result in the mortality of flora and fauna, and secondary contamination if animals or birds ingest any contaminated material. Similarly, hazardous waste would be generated through the use of absorbents to clean up a spill. The extent of the impact of a fuel spill will vary depending on the nature of the fuel and the scale and location of the incident.

While the proposed support activities for the 2024 – 2025 and 2025 – 2026 Seasons have been assessed for the programme of works as outlined within this IEE, the majority of these support activities are required each and every season in order for operations to continue at Rothera.

The fuel or hazardous substance release impacts associated with support activities are considered to cause direct, indirect, and cumulative impacts on both the marine and terrestrial environmental at Rothera and within the surrounding area. A pollution incident has the potential to result in the mortality of flora and fauna, and secondary contamination if animals or birds ingest any contaminated material. Similarly, hazardous waste would be generated if absorbents are used as a result of a spill.

There would also be impacts if any liquid H_2O_2 used for the potable water sterilisation (No. 27) were to be introduced into the surrounding terrestrial and marine environments. However, BAM contractors will be briefed and follow procedure on the requirement to capture any H_2O_2 released, when water is being drawn from various outputs during the initial testing of the system, in a holding tank, and to wait 24 hours until the H_2O_2 has naturally dissipated, before being pumped to the STP. Likewise, for the flushing/cleaning of the LTHW systems (No. 26), there would be hazardous substance release impacts if contaminated water (water combined with system cleaner and commercial inhibitor) were to be discharged into the sea. Thus, the contaminated water is to be safely captured and stored in IBCs, to be shipped back to the UK at the earliest opportunity.

The fuel or hazardous substance release impacts associated with the proposed support activities would occur across both 2024 – 2025 and 2025 – 2026 Seasons. However, any resulting fuel or hazardous substance impacts would be temporary in duration, as indicated by the nature and mitigation of previous examples of fuel and / or oil spillages at Rothera.

Mitigation for the fuel and hazardous substance release is available which is discussed in more detail within Table 11-4 and Section 13, but it should be noted that this will not eliminate the effect.

11.13 Non-Native Species Introduction Impacts

11.13.1 Construction Activities

There are no potential non-native species introduction impacts associated with the proposed Construction Activities.

11.13.2 SI and Condition Surveys

There are no potential non-native species introduction impacts associated with the proposed SI and Condition Surveys.

11.13.3 Monitoring Activities

There are no potential non-native species introduction impacts associated with the proposed Monitoring Activities.

11.13.4 Support Activities

Non-native species impacts associated with the proposed support activities have the potential to cause a direct and cumulative impact as a result of species introduction through importation of cargo and people to Rothera. Introduced species may become established in ice-free areas with negative impacts upon local ecosystem structure and function, endemic species and associated scientific research and thereafter have the potential to be transported from Rothera across the continent on BAS transport.

The support activities associated with non-native species introduction are considered to be a vital function for operations at Rothera. While the proposed support activities for the 2024 – 2025 and 2025 – 2026 Seasons have been assessed for the programme of works as outlined within this IEE, these support activities are required every season in order for operations to continue at Rothera. The nature of these support activities is such that the risks of non-native species introduction associated are not considered to significantly differ to previous seasons.

Mitigation for the introduction of non-native species is available and well-established which is discussed in more detail within Table 11-4 and Section 13.

11.14 Disturbance to Native Flora and Fauna Impacts

11.14.1 Construction Activities

The disturbance of native flora and fauna impacts associated with all construction activities are considered to cause a direct and cumulative effect on local flora and fauna. Disturbance, injury, or fatality to local fauna could result in avoidance or stress behaviour, injury and/or nest abandonment. This could lead to a cumulative reduction in local populations. The extent of disturbance will vary depending on the nature of the activity.

The source of disturbance associated with the proposed construction activities are considered to be restricted to the periods when these activities taking place throughout the 2024-2025 and 2025-2026 Seasons and will not be continuous. The activities will be temporary in duration during the programme of works as outlined within this IEE, although are recognised to span two seasons collectively. For the purposes of assessment, it has been assumed that the proposed activities are occurring concurrently to allow the assessment of potential risks and impacts to sensitive receptors in proximity of this location.

This assumption has been taken as the worst-case scenario for environmental assessment purposes and is not intended to reflect the exact programme for the proposed construction activities. Resource and equipment constraints are considered likely to manage the effects associated with concurrent disturbances at Rothera.

The proposed construction activities are being undertaken at various locations throughout Rothera, with sensitive ecological receptors present. The latest data on skua nest locations, Figure 10-1 Environmental Constraints at Rothera, suggests that the RMP activities are in closest proximity to nests. As the nearest active skua nests are located within the exposed rock faces approximately 70 m to the east of Vikings House at Rothera, and approximately 40 m from the moss patch.

A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy equipment such as the use of power tools and large machinery and consideration given to the impact on wildlife. Animals on land (except nesting birds) will be given the opportunity to move away from the noise source before it reaches its highest level. At this point, the equipment may be used continuously.

11.14.2 SI and Condition Surveys

The disturbance to native flora and fauna impacts associated with the SI and Condition Surveys have the potential to cause a direct and cumulative effect on local flora and fauna. Disturbance, injury, or fatality to local fauna could result in avoidance or stress behaviour, injury and/or nest abandonment. This could lead to a cumulative reduction in local populations. The extent of disturbance will vary depending on the nature of the activity.

Potential impacts associated with the East Mooring Point SI activity (No. 17), comprising hand-digging and GPR testing, have the potential to disturb nearby bird nests. However, it is unlikely that the SI works would significantly impact bird life, as there would be negligible sound, vibration, dust, or light impacts, due to the activity being carried out by hand, requiring just two contractors travelling to the site by foot and there being no accompanying machinery. In addition, the duration of this SI is considered to be temporary within the 2024-2025 Season.

The latest available data on skua nest locations, Figure 10-1, also suggests that there is no active skua nest adjacent to the proposed SI works at the East Mooring Point site. The location of the hand digging will seek to avoid environmental constraints, as far as reasonably possible, and the SI team will be accompanied by a BAS field guide to enforce this.

There is also potential disturbance to native flora and fauna associated with the Condition Surveys (No. 16), through the use of vehicles and machinery, namely the MEWP, which may cause minor noise and vibration impacts, see Section 11.6.2, potentially resulting in avoidance or stress behaviour, injury and/or nest abandonment. A key receptor susceptible to impacts caused by this activity is skua nests. The latest skua nest data, Figure 10-1, suggests that most of the known active skua nests are located sufficient distance away from the activity location. However, the closest skua nest is approximately 60 m east of NBH, one of the buildings due to be surveyed.

Skua monitoring will continue throughout the condition survey programme, to obtain updated information on nest activity that can be used to inform any additional mitigation methods and future AIMP works. Particular attention will be paid to the skua nest locations during and after works are complete. If agreed noise and/or vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening.

11.14.3 Monitoring Activities

There are no potential disturbances to native flora and fauna impacts associated with the proposed Monitoring Activities.

11.14.4 Support Activities

Disturbance associated with several support activities during the 2024 – 2025 and 2025 – 2026 Seasons are considered to cause direct and cumulative noise impacts to local fauna, potentially resulting in avoidance or stress behaviour, injury and / or nest abandonment and damage to local flora. The extent of disturbance generated will vary depending on the nature of the activity.

The remote location of Rothera and the challenge in accessing this location results in largely unavoidable disturbance effects associated with support activities to transport personnel and cargo to Rothera, and these are not considered to significantly differ to those experienced in previous seasons. These activities, such as SDA arrivals, aircraft landings on the runway, site setup and presence of personnel on site occur frequently and continuously throughout the year and are highly managed to ensure impacts to the local environment are minimised. Wildlife is considered to be habituated to the disturbance associated with the support activities that occur at Rothera, as demonstrated through the continued presence of active skua nests and wildlife present on and around the site. Support activities during the 2024 – 2025 and 2025 – 2026 Seasons will be undertaken for the required duration of the presence of personnel at Rothera (during the austral summers) as outlined within this IEE.

The installation of the new survey control points (No. 30) has been included as an activity that could potentially incur disturbance to flora and fauna, due to the worst-case option for the proposed control point behind the hangar requiring intrusive groundworks to clear the area of loose rock, and laying of concrete to secure a steel pin which would act as the control point (Section 5.7). The latest data on skua nest locations, Figure 10-1 Environmental Constraints at Rothera, suggests that there are two inactive skua nests in close proximity to the proposed survey control point installation. Therefore, these nests should be checked prior to any work commencing to confirm they remain inactive, as well as skua monitoring to continue throughout the survey control point installation programme at that location. It should be noted, however, that potential disturbance to flora and fauna would only occur at the location behind the hangar, as the six other locations along the edge of the runway would be unlikely to result in impacts on local wildlife due to the non-intrusive nature of the installations at these locations (Section 5.7).

Mitigation and monitoring for disturbance to native flora and fauna is available which is discussed in more detail within Table 11-4 and Section 13, and should be read in conjunction with the mitigation measures recommended for noise emissions in particular.

11.15 Visual Impacts

11.15.1 Construction Activities

The visual impacts associated with construction activities, such as the construction of the new VLF hut and presence of construction equipment, are considered to cause a direct and cumulative impact to the built and natural landscape at Rothera by changing the visual and local aesthetic values of the surrounding landscape.

The installation of the VLF hut (No. 12) and building deconstruction (No. 14) will have permanent effects on the visual setting, through the installation and removal of buildings, respectively. In the context of the wider site uses at Rothera, these activities are not considered to significantly alter the landscape and visual setting. The visual impacts associated with the other construction activities are temporary in nature either due to the short-term presence of construction equipment to facilitate the installation of services or due to the below-ground nature of the works, thus although potential impacts exist, they are not considered to cause visual impacts at Rothera.

11.15.2 SI and Condition Surveys

Visual impacts associated with the SI hand-digging at East Mooring Point (No. 17) are considered to cause minor direct impacts to the natural landscape at Rothera by changing the visual and local aesthetic values of the surrounding landscape, through the removal of snow and ice to access the underlying geology. However, any visual impacts associated with this SI activity are considered to be temporary in nature, due to the short-term duration of the snow clearance, which is expected to be re-covered during austral winter. Thus, although potential impacts exist, they are not considered to cause visual impacts at Rothera.

11.15.3 Monitoring Activities

There are no potential visual impacts associated with the proposed Monitoring Activities.

11.15.4 Support Activities

Visual impacts associated with support activities are considered to cause a direct and cumulative impact to the built and natural landscape at Rothera by changing the visual and local aesthetic values of the surrounding landscape due to the presence of additional cargo, construction sites and personnel. The extent of the visual impact will vary depending on the nature of the activity.

The installation of the new survey control points (No. 30) has been included as an activity that could potentially incur visual impacts, as the worst-case option for the control point due to be installed behind the hangar requires the fitting of an approximately 1 metre long steel pin into the ground, which would act as the control point (Section 5.7). It should be noted, however, that this area already contains existing visually intrusive infrastructure, such as the NDB.

The visual impacts associated with support activities at Rothera during the 2024 – 2025 and 2025 – 2026 Seasons will be temporary in duration during the programme of works as outlined within this IEE and are not considered to differ significantly from previous seasons.

Mitigation and monitoring for visual impacts is available which is discussed in more detail within Table 11-4 and Section 13.

11.16 Heritage Impacts

BAS has operated from Rothera since 1975. Whilst there are no formally designated Historic Sites and Monuments (HSM) at Rothera, it does have a rich cultural heritage which has developed over the years. Heritage is important to BAS and the wider UK Antarctic community so potential impacts to heritage have been considered in this IEE.

A heritage survey was undertaken at Rothera in December 2016 by Ieuan Hopkins, BAS Archives Manager and Rachel Clarke, BAS Head of Environment Office, to identify objects with potential heritage significance.

The purpose of the survey was to:

- identify those items of heritage value which will require ongoing management and / or extraction prior to the Rothera re-development;
- to ensure that those items of heritage value put at risk by the Rothera redevelopment are appropriately protected;
- to elicit the views of Rothera personnel, as stakeholders, with regards heritage in general, and the heritage value of items at Rothera; and
- to enable these views to be factored into the redevelopment process and assessments of heritage value.

Six key heritage artefacts were identified in the survey. This included Bingham's House, which is included in the proposed scope for the Deconstruction of Existing Assets activity (see Section 4.4.9). However, the statement of significance which accompanies the survey results, states that the building does not have any heritage value and therefore, after consultation with the Environment Office and UK Antarctic Heritage Trust, recommended the removal of Bingham's Building as part of the broader Rothera redevelopment.

There are therefore no potential heritage impacts associated with the construction, SI and condition surveys, monitoring, and support activities proposed for the 2024 – 2025 and 2025 – 2026 Seasons.

11.17 Assessment of Climate Change

It is vital to consider the potential impacts of the proposed works to global climate change (through atmospheric emissions), along with their vulnerability to the effects of climate change.

11.17.1 Contribution to Global Climate Change

The potential to minimise the impacts of climate change at Rothera is presented by the opportunity to use alternative fuel sources, such as Hydrogenated Vegetable Oil (HVO), to reduce GHG emissions. A trial of HVO fuel was undertaken during the 2022 - 2023 Season. The HVO trial was successful, but BAS will not be using HVO in the 2024 – 2025 and 2025 – 2026 Seasons because the fuel supply and infrastructure requirements at Rothera are not currently able to support the transition to HVO fuels. The use of HVO at Rothera is currently something that BAS are considering more strategically as they continue to innovate. BAM trial report[60] which compared NO_2 and CO_2 emissions from an on-site generator using traditional MGO and Green D+, an enhanced type of HVO fuel. The CO_2 emissions were reduced from 172.0 ppm (MGO) to 86.5 ppm (HVO), and the NO_2 emissions were reduced from 44.6 ppm (MGO) to 32.2 ppm (HVO). Therefore, the trial established that there was a reduction in emission and a more complete combustion while using the Green D+ HVO fuel.

The electrical power at Rothera is currently provided by four Volvo TAD 752GE diesel engines, coupled to AC generators housed in the generator shed. However, after the operational hand-over of the Discovery Building from 30th April 2025, Rothera will instead be primarily powered by four new CHP engines, successfully installed at the ground floor of Discovery Building in April 2024. Thus, electricity at Rothera will be supplied via the CHP engines, plus small amounts from the solar PV panels installed on the exterior of Discovery Building. Thermal generation would be via the CHP engines, as well as two MGO boilers, plus a small amount from the PV. These power updates are consistent with the Rothera Decarbonisation Strategy, which aims to have permanently zero GHG emissions in its operational activity at Rothera by 2030 (Section 2.3).

The BAS Operations Team are constantly innovating to minimise the BAS contribution to climate change through the routing of the SDA. The route of the SDA is mapped and monitored and from this data the team propose the most efficient route for the SDA in order to minimise trips, emissions, and fuel use. Therefore, the route optioneering undertaken by the BAS Operations Team ensures the most efficient transportation of personnel to minimise the contribution global climate change associated with BAS Operations.

11.17.2 Climate Change Resilience

As a result of high levels of variability in climate modelling in the Antarctic, the accuracy of current climate change trends and potential impacts at Rothera are difficult to ascertain. The impacts of climate change are already evident at Rothera and the surrounding environment, and therefore an assessment of these changes alongside the potential for future exacerbation of these changes has been considered within this IEE. Climate projections for this region are continued periods of cold temperatures and snowfall alongside increased frequencies of rainfall and higher temperatures. The confidence in increased storm events is lower than with other changes, however the occurrence of storm events is acknowledged. This section considers the vulnerability of the constructed elements of the proposed works, in other words those elements that will remain in situ and be subject to a future climate.

[60] BAM Nuttall, 2023. AIMP – Green D+ HVO Trial Results

For the purpose of this CCR assessment, the impacts of increasing temperatures and other climate change impacts, such as more extreme weather events, at Rothera have been considered within this IEE. As the duration of the proposed activities for the 2024 - 2025 and 2025 - 2026 Seasons is approximately two years these works are considered to be short term. Therefore, the effects of climate change are not considered to give rise to significant adverse effects during this time period, although effects of climate change are already being recorded at Rothera and within the surrounding environment.

When determining the sensitivity of receptors in relation to climate change effects the susceptibility (ability to be affected) and vulnerability (potential for exposure) of the receptor are considered. The consequence of effects has considered the impacts on safety and disruption to construction or operation of the proposed development. Professional judgement has been used to determine the sensitivity of receptors and consequence of effects.

Construction Effects

During construction, snowfall and ice formation will continue at Rothera which could lead to damage to equipment alongside delays to the construction programme. Equipment at Rothera is considered sufficient to withstand cold temperatures and snowfall, and method statements are in place to ensure that only suitably qualified personnel use equipment during appropriate weather conditions.

Storm events and high winds during construction could occur, causing erosion of stockpiles, dust generation and transmission and damage to equipment. In addition, strong winds could impact support operations such as transport of personnel and cargo to Rothera by aircraft. Periods of heavy snowfall are projected to continue at Rothera during the construction phase.

The selected gravel surface material of the runway has proven to be an effective solution in the extreme climatic conditions experienced at Rothera over the last 30 years and is resilient to cold temperatures and can be constructed in harsh environments. The construction programme includes consideration of ‘lost’ days due to adverse weather. More vulnerable activities should take place in appropriate weather conditions. Increasing temperatures have the potential to increase the risk of non-native species being transported to Rothera.

The proposed mitigation measures to manage stockpiled material and dust are considered sufficient to manage the construction risks due to climate change. Risks presented by climate change are considered to be suitably managed through the project specific Biosecurity Plan and BAS Biosecurity Regulations. The transport of cargo and personnel to Rothera is considered to be appropriately managed through operational and voyage procedures.

Construction method statements include a requirement to use appropriate equipment for cold weather conditions and for maintenance to be undertaken by suitably qualified personnel.

The potential for significant adverse effects due to climate change are in the medium to long-term, and so the focus of this assessment is on the operational stage during the operational lifetime of the proposed activities for the 2024 – 2025 and 2025 – 2026 Seasons which is considered to be 30 years.

Operational Effects

During the operational period of the proposed development, increased temperatures and more frequent periods of high winds are anticipated. This could result in disruptions to the air operations to and from Rothera. Increased temperatures during operation could also increase the shrinking of permafrost and cause differential settlement of the repaired runway surface and the SWS; however, the selection of surface material reduces the risk of degradation, meaning it is not susceptible to heave and shrinkage. Increased temperatures are therefore not anticipated to significantly impact upon the operation of the proposed projects to be completed during the 2024 – 2025 and 2025 – 2026 Seasons.

The proposed runway defect repairs will ensure that the surface of the runway remains safe throughout the operational lifetime in a variety of weather conditions and increases resilience to the effects of climate change. The potential effects of sea level rise are acknowledged; however, the effects of sea level rise are not considered to significantly impact the runway on the medium term.

The proposed upgrades to the SWS will ensure that they are fit for purpose and resilient to the impacts of climate change one the activities proposed for the 2024 – 2025 and 2025 – 2026 Seasons have been completed.

11.18 Evaluation of the Environmental Impacts

In Section 11.4 the potential environmental impacts associated with the proposed activities have been identified. This section evaluates those impacts in order to identify both the significance and risk of the impact occurring.

Each potential impact has been assessed against the following criteria:

- Extent of impact – area or volume where changes are likely to be detectable;
- Duration of impact – time period during which changes are likely to occur;
- Probability of the impact occurring; and
- Severity of the impact if it were to occur – a measure of the amount of change on the environment which also considers the resilience of the environment and its ability to recover from the impact.

Each criterion for each impact is given a score from 1 – 5 to identify whether it is considered ‘very low’, ‘low’, ‘medium’, ‘high’ or ‘very high’. Table 11-2 provides an explanation and definition of the scale used.

Table 11-2 Impact Significance Criteria

Impact Criteria	Definition of Scoring Values				
	Very Low (VL) 1	Low (L) 2	Medium (M) 3	High (H) 4	Very High (VH) 5
Extent of Impact	Site specific: Confined to the construction site, specific asset, or laydown areas	Local: Confined to Rothera and local marine environment	Regional: Northwest Antarctic Peninsula (Biogeographic region)	Continental: Antarctica and Southern Ocean south of 60 °S	Global: Earth and atmosphere
Duration of Impact	Minutes to days	Weeks to months	Several seasons to several years	Decades	Centuries to millennia
Probability of Impact	Very unlikely to occur under any circumstance	Unlikely to occur under normal operations & following standard BAS procedures	Possible if standard BAS or project specific procedures are not followed	Probable. Likely to occur during the project	Unavoidable. Certain to occur
Significance/Severity of Impact	No direct impact on the environment and local ecosystems. Recovery is definite	Impacts may occur but are less than minor or transitory. Reversible in the short term	Changes to the environment and local ecosystem are minor or transitory. Recovery is likely	Changes to environment and local ecosystem are greater than minor or transitory. Recovery is slow and uncertain	Major changes to the environment and local ecosystem which are irreversible, certain to occur and unavoidable. Recovery unlikely

11.19 Risk Scoring

Once the significance criteria have been scored for each impact, this is then used to calculate the overall risk score by using the following calculation:

Risk Score = Extent x Duration x Probability x Severity

By multiplying the value of each criterion, it produces a risk score between 1 and 625. This is repeated after the mitigation measures have been implemented to allow for a comparison and to demonstrate whether the mitigation measures have resulted in a reduction of the risk score. The higher the number the greater the environmental risk of the impact.

The risk score values have been split into categories of impact and colour coded for ease of identification. As presented in Table 11-3, they are aligned to the three levels of impact significance identified in Article 8(1) of the Environmental Protocol.

Table 11-3 Risk Scoring Criteria

Description	Risk Score	Environmental Impact and Assessment†
Impact acceptable and will be managed through normal operating procedures and outlined mitigation measures	1-60	Less than minor or transitory
Impact needs active management through mitigation measures and monitoring	61 -120	No more than minor or transitory
Impact significant. If no practical mitigation measures are possible then BAS senior management must decide whether to accept the risk.	121 – 625	More than minor or transitory
† As defined in Article 8(1) of the Environmental Protocol and outlined in Section 1.2.		

In some cases, there are differing scales of impacts of extent, duration, probability and / or severity on environmental aspects for different individual activities, within the wider categorisation of:

- Construction;
- SI and Condition Surveys;
- Monitoring; and
- Support activities.

In these cases, the activity with greatest impact has been used to calculate the risk score, to provide a worst-case scenario for assessment and to ensure mitigation is sufficient to cover the potential effects that could arise.

11.20 Risk Response

Aligned with the risk score, a risk response has been identified for each impact. Three different overarching responses are identified:

- Avoid – apply mitigation so that the impact does not occur
- Reduce – apply mitigation to reduce the risk of the impact occurring
- Accept – acceptance of the risk of the impact occurring with no further mitigation.

Where ‘avoid’ or ‘reduce’ have been assigned to an impact, the response should involve applying the normal operating procedures and mitigation measures to eliminate or reduce the risk. The risk score is then recalculated. Where there are no practical mitigation measures for an impact the response can only be ‘accept’. Therefore, if the activity is undertaken, the resulting impact must be accepted.

11.21 Impact Assessment

Table 11-4 Potential Environmental Risks from Construction, SI and Condition Surveys, Monitoring and Support Activities. details the environmental impacts associated with the proposed AIMP Phase 2 IEE activities and provides a summary of the risk response and the residual risk once mitigation measures have been assigned, if appropriate and available.

Table 11-4 Potential Environmental Risks from Construction, SI and Condition Surveys, Monitoring and Support Activities.

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and / or compaction with a machine excavator or whacker plate / roller [RMP] 14. Installation or re-routing of buried power / data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]	Atmospheric emissions	Contribution to regional and global atmospheric pollution and local heavy metal and particulate fallout	Direct, Cumulative	5	3	5	2	150	Reduce	• Before procuring new equipment for the project, ensure that all options for repair/re-use/loan of existing equipment have been considered. • Ensure that all operations at Rothera are as efficient as possible to reduce excess fuel use. • Generators and plant will be selected which balance efficiency and reduced emissions, with reliability, serviceability, and available fuel at Rothera. • Incorporate clean energy sources into site-wide electricity use and thermal generation, where possible – e.g. the new PV solar panels mounted on Discovery Building. • Regular inspections and maintenance will be carried out to ensure all vehicles, plant and generators operate efficiently, as per the BAM PMP. • Where practical, all drivers will be instructed to turn off engines during periods of waiting for 15 minutes or more. • Rationalisation of plant and equipment shipped to Rothera will be undertaken. • All staff will be briefed on energy efficiency whilst on Rothera as part of the pre-deployment training. • Only staff essential to the proposed works will be deployed to Rothera. • Data will be collected and the increased contribution to atmospheric pollution from the deployment of personnel and cargo will be accounted for in the BAS Energy and Carbon Dashboard • Good programme resource management will be applied across project activities to mitigate overall duration impact – e.g. efficiency of vehicle uses on construction activities; and apply minimal energy use during winterisation between seasons. • Movement of materials, such as stockpile use, will be recorded to maintain up to date record of remaining material quantities and avoid the need for additional trips at Rothera and/or cargo trips. • Incineration of waste is to be minimised, as far as is reasonably practicable. • If available, use alternative fuels to reduce emissions Monitoring: • Fuel use during construction will be recorded and reported in the BAS Energy and Carbon Dashboard.	5	2	3	2	60	Less than minor or transitory
<u>SI Works and Condition Surveys</u> 16. Visual / non-intrusive condition surveys of existing structures (including use of MEWP) [RENEW]			Direct, Cumulative	5	2	5	2	100	Reduce		5	2	5	1	50	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to and from Rothera 22. Transport of Personnel to and from Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 25. Fuel Management and Refuelling 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 31. Crane Winterisation [RMP]			Direct, Cumulative	5	3	5	2	150	Reduce		5	2	4	2	80	No more than minor or transitory
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and / or compaction with a machine excavator or whacker plate / roller [RMP] 12. Installation of new buildings by hand [VLF] 13. Filling of gabions and routing of cable [VLF] 14. Installation or re-routing of buried power / data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]	Noise and vibration emissions	Disturbance to local fauna resulting in stress and avoidance behaviour, injury and/or nest abandonment	Direct, Cumulative	2	3	4	3	72	Reduce	• All vehicles to maintain a 10-mph speed limit on site, enforced as standard procedure at Rothera. • Plant items will be positioned to ensure exhaust outlets point away from sensitive receptors. • Regular maintenance of all plant and vehicles to ensure they are working efficiently and generating as little noise as possible. • A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give animals on land, except nesting birds, the opportunity to move away from the noise source before it reaches its highest levels. • Consideration of the impact of noisy activities to all wildlife in the vicinity will be given. • If agreed noise and/or vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening. • Where programming and resource allows, works to be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-cumulative noise impacts.	2	2	3	2	24	Less than minor or transitory

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
<u>SI Works and Condition Surveys</u> 16. Visual / non-intrusive condition surveys of existing structures (including use of MEWP) [RENEW]				2	2	3	3	36	Reduce	• The transportation of personnel or cargo will take the most optimal route to minimise potential impacts on marine mammals. Monitoring: • Continuous noise monitoring will take place at Rothera to ensure noise levels do not exceed agreed levels of 75 dBA equivalent 12-hour and 80 dBA equivalent 1-hour, which could cause adverse impacts to local fauna (notably seals and birds). • Continuous vibration monitoring will take place at Rothera to ensure vibration dose values (VDV) do not exceed 2.4 $ms^{-1.75}$ and vibration levels measured as Peak Particle Velocity (PPV) do not exceed the values outlined in DIN 4150-3 Effects of Vibration Line 2. • Skua monitoring will continue throughout the construction programme, as well as the SI Works and Condition Surveys, to obtain updated information on nest activity that can be used to inform any additional mitigation methods and future AIMP works. Particular attention will be paid to the skua nest locations during and after works are complete.	2	2	2	2	16	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to and from Rothera 22. Transport of Personnel to and from Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 25. Fuel Management and Refuelling 26. Flushing/Cleaning of LTHW Systems 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 30. Survey Control Point Installations 31. Crane Winterisation [RMP]				3	3	4	3	108	Reduce		2	2	3	2	24	Less than minor or transitory
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and/or compaction with a machine excavator or whacker plate / roller [RMP] 14. Installation or re-routing of buried power / data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]				2	3	4	3	72	Reduce	• For activities likely to produce high levels of dust, dust suppression equipment should be used and/or roadways should be damped down with seawater, when required. • Where practicable, activities which are anticipated to generate dust are to be kept downwind of sensitive receptors and are not to be undertaken in close proximity to known vegetation or ice locations. • All routes used by vehicles and plant will be well maintained and have compacted surfaces. • The drop height of materials during stockpiling, processing, and loading operations will be limited. • Minimise double handling of materials to reduce the overall number of tipping actions. • All vehicles to maintain a 10-mph speed limit on site, enforced as standard procedure at Rothera. • All plant and equipment will be maintained on a regular basis, as per the BAM PMP. • All cement mixing will be carried out in accordance with the method statement and cement will not to be mixed externally on windy days, as advised by the Site Manager and Rothera Station Leader. • If agreed dust levels are exceeded, works in that area will cease until additional mitigation measures can be implemented. • The Meteorological Team will provide a weather forecast to the Site Manager every morning. This will be reviewed by the Site Manager in conjunction with the Rothera Station Leader to inform the decision on which activities can proceed that day and if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations, for example incineration of waste and cement mixing, if it is not possible to control dust by other means. Monitoring: • Continuous dust monitoring will take place to ensure dust levels do not exceed agreed levels. A PM_{10} limit of 50µg/m^3/24 hours is proposed and a total suspended particle (TSP) limit of 250µg/m^3/15 minutes. • Wind level data to continue to be captured from the Met Mast by the Met team every morning. The Met team will provide a weather forecast to the BAM project manager who will assess the impacts of wind	2	2	2	3	24	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to and from Rothera 22. Transport of Personnel to and from Rothera 24. Site Set-Up and Presence of Personnel 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 30. Survey Control Point Installations 31. Crane Winterisation [RMP]	Dust emissions	Impact from dust deposition on ice ramp (increased melt), local flora (smothering) and inhalation (local fauna)	Direct, Cumulative	2	3	4	3	72	Reduce		2	2	3	2	24	Less than minor or transitory

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
										on dust generating activities and apply mitigation as required.						
<u>Construction Activities</u> 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 12. Installation of new buildings by hand [VLF] 15. Building strip-out and deconstruction [RMP]	Waste	Impact due to increased waste sent to UK landfill and waste release to the local environment	Direct	2	2	4	2	32	Reduce	• The SWMP will be strictly adhered to for all construction waste. • The storage of waste streams shall be segregated for recycling, re-use, or recovery at a dedicated area for the storage of waste, in accordance with the SWMP. Segregation of waste will allow consolidation of packing, thus reducing volumes required for shipping back to the UK. • The waste hierarchy will be applied. • The packaging of materials / supplies will be minimised where reasonably practicable prior to the consigning of cargo to Antarctica. • Import of raw materials will only be undertaken where necessary, and in quantities required to avoid surplus material. • Waste to be stored in the appropriate storage method. • Daily checks to ensure waste is contained to avoid being blown around site. • Provision of a BAM staff member dedicated to environmental management who will ensure that all waste is managed appropriately. • All construction waste is to be returned to the UK and disposed of by the appointed licensed contractors. • BAM has a commitment to achieving an 80% diversion of construction waste from landfill and a 90% diversion of all waste from landfill. Project specific targets may vary. • Any waste materials deemed to be in good condition will be offered to the Station Leader for potential re-use. • Pre-deployment training on waste management for all operatives. • All team members are to read and be briefed on the 'Field Operations Manual' relating to Environmental Management and the BAS Waste Management Handbook. • Human waste generated off-site (e.g. during the transportation of personnel) will be incinerated at Rothera, otherwise all human waste shall be treated and discharged via the STP. • UV will be irradiated at the STP prior to discharge to mitigate the impact of the discharge. • All toilets and washing facilities are connected to the foul drainage system and will discharge via the STP. • Any cementitious or grout wash waters produced during construction will be neutralised to a pH of 7.0 using citric acid prior to discharge to ground. Cementitious and grout materials are mixed in the BAM Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the BAM Fitters Workshop. • Domestic water system sterilisation to follow relevant contractor procedures. Excess wastewater containing hydrogen peroxide drawn through tap outlets to be captured in holding tanks, to allow hydrogen peroxide to naturally dissipate in water over 24 hours. • Chemicals and contaminated waters discharged through the LTHW system will be contained and transported as waste. • The loss of any equipment will be reported in Maximo. Monitoring: • Waste statistics will be collated for future monitoring and assessment purposes. • Daily checks of the site. • Neutralised water monitoring and recording.	2	2	3	2	24	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to and from Rothera 22. Transport of Personnel to and from Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 25. Fuel Management and Refuelling 26. Flushing/Cleaning of LTHW Systems 27. Sterilisation of Potable Water [RMP] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 31. Crane Winterisation [RMP]			Direct, Indirect, Cumulative	2	3	4	3	72	Reduce		2	3	2	2	24	Less than minor or transitory

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
										• Continuous review of opportunities to improve efficiency of water usage STP operations.						
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and/or compaction with a machine excavator or whacker plate/roller [RMP] 11. Ground clearance and levelling by hand [VLF] 12. Installation of new buildings by hand [VLF] 13. Filling of gabions and routing of cable [VLF] 14. Installation or re-routing of buried power / data cable [RENEW, RMP]	External light emissions	Disturbance and avoidance impact to local fauna, potential for disorientation of birds resulting in injury or mortality due to strikes	Direct	2	3	4	3	72	Reduce	• The proposed activities will be undertaken during daylight hours as far as reasonably practicable, and the intensity and use of lighting will be minimised during low light hours. • In the instance when lighting rigs are to be used, they will be positioned angled towards the ground and not horizontally. • When not in use lights are to be turned off and where possible external lighting should incorporate movement sensors or similar technology to minimise the during of illumination. • In the event of a bird strike, a suitably trained bird strike response staff member will take charge of the bird's care in accordance with the BAS Wildlife Interaction Manual. • Lights will be switched off immediately if more than five bird strikes occur in one period of work. Monitoring: • All bird strikes will be recorded on Maximo for monitoring and management purposes	2	3	3	2	36	Less than minor or transitory
<u>Monitoring Activities</u> 18. Runway surface degradation monitoring [RUNSUR]			Direct	2	3	4	3	72	Reduce		2	3	2	2	24	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to and from Rothera 22. Transport of Personnel to and from Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 31. Crane Winterisation			Direct	2	3	4	3	72	Reduce		2	3	3	2	36	Less than minor or transitory
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and/or compaction with a machine excavator or whacker plate / roller [RMP] 11. Ground clearance and levelling by hand [VLF]	Physical presence and use of space	Disruption to station operations and science.	Direct, Indirect, Cumulative	2	3	4	3	72	Reduce	• All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE. • Materials will not be used/removed from sensitive locations without prior approval of BAS Environment Office. • Changes to the locations used for any activities are to be agreed with BAS Operations, the BAS Environment Office and FCDO. • Evacuation plans will be agreed with station management to ensure appropriate safe evacuation occurs with minimal disturbance to day-to-day activities on site. • The BAS Project Support Coordinator will prepare a Rothera Station Integration Plan (RSIP) to demonstrate adequate space use on site for the proposed activities.	2	2	3	3	36	Less than minor or transitory

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
12. Installation of new buildings by hand [VLF] 13. Filling of gabions and routing of cable [VLF] 14. Installation or re-routing of buried power / data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]										• Pre-deployment training sessions to be held with all BAM and BAS staff.						
<u>SI Works and Condition Surveys</u> 16. Visual / non-intrusive condition surveys of existing structures (including use of MEWP) [RENEW] 17. Hand-Digging and GPR Survey for East Mooring Point [WHARF]			Indirect	2	2	3	3	36	Reduce		2	2	3	2	24	Less than minor or transitory
<u>Monitoring Activities</u> 18. Runway surface degradation monitoring [RUNSUR]			Indirect	1	3	3	2	18	Reduce		1	2	2	1	4	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to and from Rothera 21. Storage of Cargo at Rothera 22. Transport of Personnel to and from Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 25. Fuel Management and Refuelling 26. Flushing/Cleaning of LTHW Systems 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 30. Survey Control Point Installations 31. Crane Winterisation [RMP]			Direct, Indirect, Cumulative	2	3	4	3	72	Reduce		2	3	3	3	54	Less than minor or transitory
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and/or compaction with a machine excavator or whacker plate / roller [RMP] 11. Ground clearance and levelling by hand [VLF] 12. Installation of new buildings by hand [VLF] 13. Filling of gabions and routing of cable [VLF] 14. Installation or re-routing of buried power /data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]	Physical or mechanical disturbance on land	Impacts due to ground disturbance at Rothera. Deterioration of existing road infrastructure at Rothera Physical disturbance of land due to excavation	Direct, Cumulative	2	3	4	3	72	Reduce	• All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE. • Changes to the locations used for any activities are to be agreed with BAS Operations, the BAS Environment Office and FCDO. • Minimise the footprint of all works through careful design. • All vehicles to maintain a 10-mph speed limit on site, enforced as standard procedure at Rothera. • Minimise material movements to and from stockpile locations. • Allocate a dedicated member of staff to maintain accurate stockpile records. • During replacement or decommissioning there will be an over-excavation of material to compensate for any potential localised movement of degraded plastic from ducting in the environment. • Locate SI hand-digging away from sensitive environmental constraints. • Daily checks on all routes used by construction vehicles. • Demarcation of the ASPA for the prevention of entry, including by vehicles, such as skidoos, into the environmentally sensitive area. The instructions will be passed on to relevant operatives before the transportation materials is undertaken for the VLF equipment relocation. • Contractors to be briefed on the location of the Ice Ramp and the control measures in place when working adjacent to the Hangar (control point installation). Monitoring: • Maintain accurate records of stockpile material volumes and movements. • Daily checks on all routes used by construction vehicles.	2	3	3	2	36	No more than minor or transitory
<u>SI Works and Condition Surveys</u> 17. Hand-Digging and GPR Survey for East Mooring Point [WHARF]				1	2	3	2	12	Reduce		1	2	2	2	8	No more than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 21. Storage of Cargo at Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 30. Survey Control Point Installations				2	2	4	3	48	Reduce		2	2	4	2	32	Less than minor or transitory

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
31. Crane Winterisation [RMP]										• Monitoring and maintenance of runway surface to ensure that surface remains in a safe and working condition.						
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and/or compaction with a machine excavator or whacker plate/roller [RMP] 14. Installation or re-routing of buried power / data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]	Fuel or hazardous substance release	Fuel or hazardous substance release to local environment Generation of hazardous waste Mortality to flora and fauna and secondary contamination if animals or birds ingest any contaminated material.	Direct, Indirect, Cumulative	2	3	3	4	72	Reduce	• Refuelling will be undertaken in accordance with the OSCP refuelling requirements at Rothera to ensure continual inspections are made of fuelling equipment and drip trays are placed under hose joints as a precaution - this procedure is reviewed annually. • Spill kits will be in all mobile vehicles and in well-defined and easily accessible locations on site. • Plant nappies will be used for all static plant. • A core oil spill response team of a minimum of 24 station staff will be formed and receive pre-deployment oil spill response training led by the BAS Environment Office and delivered by BAS and Oil Spill Response Ltd. This training is in addition to on-site training delivered by the Rothera Station Leader. • The OSCP will be followed for Tier 1, 2 and 3 spills. • De-winterising checks will be undertaken in accordance with the OSCP. • All plant will be inspected daily for potential leaks and condition of hydraulic oil hoses - these checks will be recorded on the daily plant check sheets and the daily activity plan compliance record. • All fuel storage tanks to be checked weekly and recorded on the BAM Environmental Inspection Checklist EC01, as current procedure. • All spills will be reported to Rothera Station Leader and BAS Environment Office. • Any cementitious or grout wash waters produced during construction will be neutralised to a pH of 7.0 using citric acid prior to discharge to ground. Cementitious and grout materials are mixed in the BAM Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the BAM Fitters Workshop. • All contaminated water resulting from LTHW systems flushing will be captured in IBCs, stored inside, and shipped back to the UK at the earliest opportunity. • Domestic water system sterilisation to follow relevant contractor procedures. Excess wastewater containing hydrogen peroxide drawn through tap outlets to be captured in holding tanks, to allow hydrogen peroxide to naturally dissipate in water over 24 hours. • The updated WQMP is to be followed for post-commissioning plan for ongoing potable water sterilisation of the water systems. • The loss of any equipment will be reported in Maximo	2	2	2	3	24	Less than minor or transitory
<u>SI Works and Condition Surveys</u> 16. Visual / non-intrusive condition surveys of existing structures (including use of MEWP) [RENEW]				2	2	4	2	32	Reduce		2	2	2	2	16	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to and from Rothera 21. Storage of Cargo at Rothera 22. Transport of Personnel to and from Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 25. Fuel Management and Refuelling 26. Flushing/Cleaning of LTHW Systems 27. Sterilisation of Potable Water [RMP] 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 31. Crane Winterisation [RMP]				3	3	3	4	108	Reduce		3	3	2	3	54	Less than minor or transitory
<u>Support Activities</u> 20. Shipping Cargo to and from Rothera 21. Storage of Cargo at Rothera 22. Transport of Personnel to and from Rothera 24. Site Set-Up and Presence of Personnel	Non-native species introduction	Non-native species introduction to and establishment at Rothera, altering the local ecosystem. Non-native species increase the risks to endemic species and on future science	Indirect, Cumulative	2	4	3	4	96	Reduce	• All personnel being deployed to Rothera will receive a pre-deployment briefing from a member of the BAS Environment Office which will cover biosecurity. • All activities will be undertaken in accordance with the BAS Biosecurity Regulations, the CEP NNS Manual and the Project-specific Biosecurity Plan. • A trained manager will inspect all plant, equipment, and materials prior to loading onto the vessel and on disembarkation/offloading at Rothera. • All equipment and materials required for the proposed activities will be thoroughly cleaned before dispatch to Antarctica. • The materials required for the new VLF hut will be treated prior to import to Rothera, including heat-treated wood. • Should soil, seeds or propagules be imported unintentionally, they must be carefully collected and removed. Rodents and insects must be exterminated immediately.	2	4	2	3	48	Less than minor or transitory

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
										• The Rothera Station Leader and the BAS Environment Office must be informed immediately if a biosecurity incident occurs. Monitoring: • Evidence of the measures undertaken will be provided in the form of completed biosecurity audit checklists. • Any biosecurity incursions will be reported immediately to the BAS Environment Office and on Maximo.						
<u>Construction Activities</u> 1. Managing runway defects, including scarification [RUNSUR] 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling, with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and / or frozen ducting and chambers [RUNSUR, RMP] 6. Waterproofing flooded and / or frozen ducting and chambers [RUNSUR] 7. Water jetting of frozen ducting [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 9. Transporting rock material [RUNSUR] 10. Ground clearance, levelling and/or compaction with a machine excavator or whacker plate/roller [RMP] 11. Ground clearance and levelling by hand [VLF] 12. Installation of new buildings by hand [VLF] 13. Filling of gabions and routing of cable [VLF] 14. Installation or re-routing of buried power / data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]	Disturbance to flora and fauna	Disturbance, injury, or fatality to fauna. Disturbance to Native Flora (e.g. Moss patch) and Fauna.	Direct, Cumulative	2	3	4	4	96	Reduce	• All staff will receive pre-deployment and on-station briefings regarding wildlife viewing and working close to wildlife, the ASPA and IBA. • All vehicles will be inspected, and wheels checked for the presence of seals and penguins before engines are started. • In the unlikely circumstance of the displacement of seals or penguins, only trained personnel will be involved– the BAS Wildlife Interaction Manual will be referred to for any contact with wildlife. • Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nests to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present. • Where programming and resource allows, works to be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-cumulative noise impacts • All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE • Changes to the locations used for any activities are to be agreed with BAS Operations, the BAS Environment Office and FCDO • The location of SI hand-digging at the East Mooring Point site will seek to avoid environmental constraints, as far as reasonably possible, and the SI field team will be accompanied by a BAS field guide during the duration of the works • If agreed noise and/or vibration levels are exceeded during the building condition surveys, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening. • Checks of inactive skua nests to be undertaken prior to the commencement of any works nearby or behind the Hangar (survey control point installation), to confirm they remain inactive, as well as ongoing skua nest monitoring during the programme of works listed below. • Demarcation of the ASPA for the prevention of vehicles, such as skidoos, into the area. The instructions will be passed on to relevant operatives before the transportation materials is undertaken for the new VLF hut. • Contractors to be briefed on the location of the Ice Ramp and appropriate control measures, such as demarcation, when installing the survey control point behind the Hangar. • All vehicles will be inspected, and wheels checked for the presence of seals and penguins before engines are started • Someone suitably trained in wildlife interaction will be present at the start of works adjacent to any known nests and noisy works will not commence without express permission of the suitably trained person present	2	2	2	2	16	Less than minor or transitory
<u>SI Works and Condition Surveys</u> 16. Visual / non-intrusive condition surveys of existing structures (including use of MEWP) [RENEW] 17. Hand-Digging and GPR Survey for East Mooring Point [WHARF]				1	2	2	3	12	Reduce		1	2	2	2	8	Less than minor or transitory
<u>Support Activities</u> 19. Vehicle, Plant, and Equipment Operation 20. Shipping Cargo to Rothera 22. Transport of Personnel to Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services 24. Site Set-Up and Presence of Personnel 25. Fuel Management and Refuelling 26. Flushing/Cleaning of LTHW Systems 27. Sterilisation of Potable Water [RMP] 28. Transportation of Construction Materials and New Structures across Rothera [VLF] 29. Removal of Waste from Rothera via Commercial Vessel [RMP] 30. Survey Control Point Installations 31. Crane winterisation [RMP]				4	3	3	4	144	Reduce		4	2	2	3	48	Less than minor or transitory

Activities	Environmental Aspect	Potential Impact(s)	Type of Impact	Extent	Duration	Probability	Significance/Severity	Risk Score (pre-mitigation)	Risk Response	Preventative or mitigating and monitoring measures	Extent	Duration	Probability	Significance/Severity	Risk Score (post mitigation)	Impact and Assessment
										• Any new solar monitoring masts installed will be fitted with reflective tags in order to prevent bird collisions • The BAS Facilities team will maintain the demarcation of the no-go zone around the moss patch and ensure it is communicated to relevant personnel at Rothera Monitoring: • Noise and vibration monitoring, as above. • Dust monitoring, as above. • Skua monitoring will continue throughout the Construction programme, as well as the SI Works and Condition Surveys, to obtain updated information on nest activity that can be used to inform any additional mitigation methods and future AIMP works. Particular attention will be paid to the skua nest locations during and after works are complete. • Monitoring data to be presented to the BAS Environment Office every two weeks unless thresholds are exceeded as part of the BAM Monitoring and Reporting Schedule, and in a final report submitted at the end of each season. • Any wildlife injury or fatality associated with the work should be reported immediately to the BAS Environment Office and reported in the BAS Incident Reporting System (Maximo). • Any impacts to the moss patch will be monitored at monthly intervals through photographic records taken from the same viewpoint, implemented throughout the Rothera modernisation programme.						
<u>Construction Activities</u> 2. Trench excavation [RENEW, RUNSUR, RMP] 3. Trench backfilling with excavated and additional material [RENEW, RUNSUR, RMP] 4. Excavation of flooded and/or frozen ducting and chambers [RUNSUR, RMP] 5. Replacement of flooded and/or frozen ducting and chambers [RUNSUR, RMP] 8. Processing, screening, and crushing of rock material [RUNSUR, RMP] 10. Ground clearance, levelling and/or compaction with a machine excavator or whacker plate/roller [RMP] 11. Ground clearance and levelling by hand [VLF] 12. Installation of new buildings by hand [VLF] 13. Filling of gabions and routing of cable [VLF] 14. Installation or re-routing of buried power / data cable [RENEW, RMP] 15. Building strip-out and deconstruction [RMP]	Visual	Visual change to the built and natural landscape altering aesthetic value of Rothera	Direct, Cumulative	2	3	4	3	72	Reduce	• Construction activities will be confined to agreed areas on site. Any changes to the locations used by BAM will be discussed and agreed with the Rothera Station management team and where appropriate the BAS Environment Office and FCDO • All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE • Changes to the locations used for any activities are to be discussed and agreed with the Rothera Station management team and where appropriate the BAS Environment Office and FCDO.	2	2	4	3	48	Less than minor or transitory
<u>SI Works and Condition Surveys</u> 17. Hand-Digging and GPR Survey for East Mooring Point [WHARF]				1	2	3	3	18	Reduce		1	2	2	2	8	Less than minor or transitory
<u>Support Activities</u> 20. Shipping Cargo to Rothera 21. Storage of Cargo at Rothera 23. Provision of Accommodation, Power, Logistical and Domestic Services. 26. Flushing/Cleaning of LTHW Systems 30. Survey Control Point Installations				2	2	4	3	48	Reduce		2	2	3	2	24	Less than minor or transitory

12. CUMULATIVE IMPACT ASSESSMENT

12.1 Introduction

Cumulative impacts occur as a result of the combined impacts of past, present and reasonably foreseeable activities. Cumulative impacts may occur over time and should be assessed by looking at other human activities occurring in the proposed locations. As with indirect impacts, cumulative impacts may not be identified until a direct impact has occurred (EIA Guidelines, 2016[61]).

Cumulative impacts may occur during the proposed AIMP activities as well as in combination with past and reasonably foreseeable activities in this region of Antarctica.

Accessing information to support cumulative impact assessments in an Antarctic context can be challenging given that the international community has placed limited emphasis on monitoring and assessing incremental, but nonetheless cumulative impacts, across broader spatial and temporal scales (Tin et al., 2009[62]).

The qualitative method used here to assess cumulative impacts has been to:

- identify activities that have occurred or are ongoing in the area covered by this EIA;
- identify activities that are planned to take place in the area covered by this EIA, over the same time period as this EIA; and
- identify the primary impacts that have occurred or are anticipated to occur from these past and planned activities.

12.2 Rothera Research Station

When considering cumulative impacts at Rothera, it is important to acknowledge that the Rothera Research Station has been in operation since 1975, and prior to that there was intermittent presence at the Rothera Point location.

Practices and awareness of impacts to the environment were not understood in the same way they are today, and what we would now consider environmental incidents may not have been observed and recorded in the same way. Therefore, there is potentially historic contamination around the Rothera location that we are currently unaware of.

Additionally, being on a point of land, on an Island, Rothera is surrounded by the marine environment, and the presence of ships for various reasons, including tourism, in the locality could also be impacting the environment. These potential impacts remain unclassified in this assessment.

Ships and smaller boats are also used for scientific research in the marine environment. This research can involve collection of benthic samples and species found in the region. While these would contribute to cumulative impacts on the benthos and marine environment, the impact of ships is not considered in detail in this IEE.

Further, other nations have stations in the same region of Antarctica as Rothera is located, but there are no records included here of any impacts that may be cumulative with the activities at Rothera.

[61] https://documents.ats.aq/recatt/att605_e.pdf

[62] Tin, T., Fleming, Z.L., Hughes, K.A., Ainley, D.G., Convey, P., Moreno, C.A., Pfeiffer, S., Scott, J., and Snape, I. 2009. Impacts of local human activities on the Antarctic environment. Antarctic Science 21, pp3-33 doi: 10.1017/S0954102009001722

12.3 Known Past Activities

Since Rothera became a permanent research station, there have been improvements to the scientific, operational, and logistical capability. Most recently these have included the Discovery Building, installation of Site Wide Services, improvements to the runway, a new larger wharf to accommodate the SDA, and the installation of temporary accommodation. Earlier development included, but was not limited to, construction of the original runway, and accommodation buildings (NBH and Admirals).

Many of the recent works have fallen under the AIMP (which began in 2014) and have been included in past CEEs (required when proposed activity is likely to have more than minor or transitory impact), IEEs (required when a proposed activity is likely to have no more than minor or transitory impact), and PEAs (required when a proposed activity is likely to have a less than minor or transitory impact) included as Table 12-1 below.

Table 12-1: Summary of EIAs for BAS activities at Rothera 2017 – 2024

Level of EIA	Name of EIA	Year	Primary Activities
CEE	Rothera Wharf Reconstruction and Coastal Stabilisation	2018	• Dismantle and replace the existing wharf with a new larger wharf built in the same location • Quarry rock
IEE	Rothera Runway Resurfacing and Lighting, Site Investigation and Condition Survey Works	2022	• Construction, mechanical and electrical works to resurface the runway, install a turning circle at the southern end, and upgrade the existing lighting infrastructure • Site investigation (SI) and survey works (inc marine) condition surveys and environmental monitoring at various locations considered suitable for renewable energy generation • SI works and condition surveys to inform the future redevelopment of the existing Hangar • Construction of a new fuel farm hut and two large steel platforms
IEE	Rothera East Beach Hut	2021	• Build a hut on East Beach, Rothera Point, as part of the NERC funded Southern Ocean Cloud (SOC) project.
IEE	Rothera Modernisation Phase 1	2019	• Construction of the new Operations Building • Replacement of the site wide services • Construction of an interim waste management facility; and • Demolition and decommissioning of Old Bransfield House, Fuchs, Vehicles Garage, Generator Shed, Bingham's, Carpenters workshop and the Miracle Span • Relocation of the Medium Frequency radar masts; • Replacement of the Bentham container; and • Repair of the aircraft hangar roof.
IEE	Rothera Site Investigation Season 2	2017	• Test pits, • Bathymetry, • Underwater investigations and sampling
PEA	Runway Southern Extension	2024	• Excavation of southern extension
PEA	RMP/Site Wide Services	2024	• Installation of earthing, external slab and fuel tank for Discovery Building
PEA	RMP/Site Wide Services	2024	• Undergrounding Site Wide services • Slope stabilisation
PEA	AIMP Combined	2023	• Mooring weights at the wharf • Hydraulic line removal at the wharf • CBR measurements and Friction tests – Runway • Runway resurfacing works
PEA	Hangar Redevelopment	2023	• Ground Investigation for foundation design • Condition survey of hangar substructure • Apron trial pits and testing

			• Access road investigation
PEA	Radar Flag re-positioning and reinstatement of trench crossings	2023	• Removal of radar flags and foundations • Install new • Excavate, remediate and reinstate five trenches across runway
PEA	Rothera South Cove Feeder Pillar cable upgrade	2023	• Provide a power connection to the South Cove feeder pillar (trench)
PEA	RMP Sitewide Services 2023-2024 Season	2023	• Underground site wide services • SWS structural repairs
PEA	Rothera Estates	2023	• Boat shed fuel tank • New Bentham container (next to existing) • Sewage tank work – Admirals
PEA	Rothera Estates	2022	• New Reverse osmosis plant • Recommissioning sewage plant

The Wharf works involved blasting and the quarrying of materials, which drastically altered the environment and landscape around Rothera Point. Likely the most recent previous activity to have such an impact was the building of the original runway in *Final Comprehensive Evaluation for the proposed construction of an airstrip at Rothera Point, Antarctica* (1989). The wharf work was assessed under *Rothera Wharf Reconstruction and Coastal Stabilisation CEE* 2018[63] CEE and caused more than minor or transitory impact at Rothera.

The activities which were identified in the Wharf CEE as having a potentially cumulative impact for the Rothera Wharf reconstruction and coastal stabilisation works are listed below:

- • Dust deposition on the ice ramp
- • Loss of ice-free ground for terrestrial habitat
- • Removal of rock resulting in a change in the aesthetics of Rothera Point
- • Increase in station footprint resulting in the loss of marine benthic habitat
- • Contribution to global atmospheric pollution

All impacts were in line with those predicted by the CEE.

As is the nature of a large site with science, operations, logistics and construction, some activities have been assessed under PEAs, or not in combination with other activities, and these may have included use of chemicals such as paints, vehicle maintenance, aircraft operations, stockpiling material, laydown areas for containers, or installing science equipment. These activities when assessed individually using PEAs have been shown to have less than minor or transitory impacts, however when considered cumulatively the overall impact is likely to have been more extensive, and an overall IEE may have been more suitable.

The use of heavy equipment and vehicles has the inherent risk of fuel and hydraulic leakages and spills, and there have been a number of spills recorded at Rothera over the years. While the best effort is used to clean these up, the rocky nature of the site means that a full clean-up is not always possible and rock staining is evident around the site. Additional spills during the proposed activities will contribute to cumulative impacts from fuel spills. In general, these result in no more than minor or transitory impact on the site and are recorded in the BAS incident management system. However, considered cumulatively over the years of operation, the impact is likely to be more significant.

12.3.1 Human Sewage

Rothera has a sewage treatment plant (STP), which captures human waste and uses microbes to treat the sewage, the remaining liquids are then released to the sea while resulting sewage sludge is incinerated. Prior to the STP being installed, human sewage would have been discharged directly to the land or sea. There are no currently known records to account for these discharges.

[63] https://www.bas.ac.uk/wp-content/uploads/2018/09/Final-CEE-Rothera-Wharf-Reconstruction-Coastal-Stabilisation-05.09.18.pdf

In recent years, there have been occasions when the STP has failed, the microbes have died, and there have been leaks in the system. At times there have been bypasses of the plant, resulting in untreated sewage going to the ground or sea.

Having Rothera at a maximum capacity during the construction compounds these issues and puts the STP under increased pressure. This is assessed to have no more than minor or transitory impact to the site.

12.3.2 Ground Disturbance

In the past, ground disturbance works were undertaken as needed and little was formally recorded as the operational need was prioritised. Since first occupation at Rothera, ground disturbance has occurred across the site in relation to new development. In more recent years, there has been ground disturbance for remediation works to deal with contamination.

During construction it is common to move rock and materials around Rothera, excavate the ground and stockpile materials. To date this has not been well documented.

In general, we consider that the area at Rothera where there are existing buildings are higher impacted areas, and most of the ground there has been disturbed or excavated over the years. The exception to this would be at depth, where digging down for foundations or undergrounding services has not happened, the natural rock layers and even permafrost may still persist.

Where ground disturbance has not yet happened, it is important to seriously consider new disturbance which would increase the highly impacted footprint and reduce undisturbed ground for terrestrial flora and fauna.

12.4 Proposed Activities in this IEE

The interaction with previous activities at Rothera encompasses all development activities including the construction of all existing buildings and the infrastructure, such as underground services. The most recent projects at Rothera include activities assessed under standalone PEAs and previous CEEs and IEEs, such as the RUNSUR IEE 2022, the RMP IEE 2019 and the Wharf CEE 2018.

The direct and indirect environmental impacts associated with these independent activities are considered to have been effectively captured within the associated documents and managed through the implementation of mitigation measures. However, unexpected and unforeseen programme overlaps with the current scope of works due to programme delays and/or resource requirements must be considered as cumulative activities, which are discussed in more detail below.

12.4.1 HANGAR

SI Works (February 2025: One Week Duration)

The Hangar SI works were partially conducted in the 2023–2024 Season, the remainder of the GI works are required to provide geotechnical information in the event that the proposed Hangar redevelopment utilises rock anchors. These works are an update on activities previously approved under the RUNSUR IEE 2022.

12.4.2 RUNSUR

Future Aircraft Capability – CBR Measurements of Runway

This activity was first approved in the RUNSUR IEE and re-approved in the subsequent AIMP Combined PEA for the 2023-2024 Season. The activity was conducted in both the 22/23 and 23/24 seasons. The proposed methodology remains the same as was previously assessed and therefore, this activity is only being assessed cumulatively for the purposes of this IEE.

CBR testing will be required as an ongoing monitoring activity to enable BAS to ensure the bearing strength of the runway remains consistent following the runway resurfacing. Testing will be undertaken during the 2024–2025 and 2025–2026 Seasons, as well as future Seasons as a yearly activity as part of business as usual/operational BAS Air Unit activities.

Future Aircraft Capability – Friction Testing

This activity was first approved in the RUNSUR IEE and re-approved in the subsequent AIMP Combined PEA for the 2023 - 2024 Season. The activity was conducted in the 22/23 season but not 23/24. The proposed methodology remains the same as was previously assessed and therefore, this activity is only being assessed cumulatively for the purposes of this IEE.

Friction testing will be required as an ongoing monitoring activity to assess the condition of the runway for aircraft performance throughout the season following the runway resurfacing. Testing will be undertaken during the 2024–2025 and 2025–2026 Seasons, as well as future Seasons as a yearly activity as part of business as usual/operational BAS Air Unit activities.

Non-Engineered Slipways

This activity was originally assessed in the RUNSUR IEE 2022. However, the work was not undertaken due to a lack of available stockpile material and the activity was postponed to the upcoming 2024-2025 Season. Two new non-engineered slipways are proposed at two locations north of the windsock, and at the site of the former temporary jetty.

12.4.3 WHARF

Wharf Mooring Weights

The Mooring Weights activity, part of the Wharf Project, was first assessed in the AIMP Combined PEA for the 2023-2024 Season, but installation was not completed. The mooring weights are required as a means of securing small boats to the wharf during the process of deployment and retrieval to increase safety during this process.

12.5 Current Activities

In addition to the activities listed in this IEE, Rothera Estates will also submit a PEA for proposed activities for the 2024-25 and 2025-26 seasons.

These activities are by their nature supporting and maintaining existing facilities and therefore are not expected to be outside of the current disturbed area of the Rothera footprint. In addition to regular maintenance, for the upcoming seasons the estates team will be completing some tasks identified in this IEE. Some potential Estates works include:

- Drum Platform Completion: a raised platform to store fuel drums is required, this activity is almost complete but requires final in-situ casting. All fuel drums in the location will be moved to the platform once complete.
- Raising of Explosive Magazines: explosive magazines are currently partially submerged under the snow, which are required to be raised and placed on existing concrete blocks.
- Incinerator Installation: a replacement incinerator at North Cove will be installed.
- Bentham Container Support Blocks: updates to the old communications container have meant that the staircase no longer meets the ground to allow access to the roof. Pre-cast concrete blocks will be put in place to act as steps.

- STP Replacement: the old STP will be replaced with a 2 ft by 20 ft containerised solution. The replacement is designed to slide into the old STP building shell and therefore minimal construction works are required.

In order to robustly assess potential cumulative effects for new scope items planned for future activities at Rothera, the scale of activities must be known both in terms of construction methodologies and operational requirements associated with the proposed activity. There is potential for future cumulative effects to arise as a result of interactions between proposed construction and planned BAS Estates activities.

Other activities that will be occurring at the same time as the IEE activities include, but are not limited to international aircraft movements, science activities including meteorological, space weather, marine activities, both via boats and diving, and research associated with the Bonner Lab and the Gerritsz (Netherlands Polar Research Program) Lab. All these activities will have impacts on the Rothera area.

A variety of existing activities related to organisations outside of BAS are also potentially occurring in the same region, at the same time as the proposed IEE activities. These may include shipping, science, expeditions, tourism and potentially construction at other stations. To date, these remain unknown in quantity and scope.

12.5.1 Science Activities

Many science activities at Rothera are long-term and continuous. Some specialise in gathering data on changes to the ecosystems such as skua monitoring, benthic surveys and sediment coring on the seabed. Others are focused on changes to ice, atmospheric science, meteorology, space weather, or geology. Antarctica is a primary location for many of these science activities due to the clean air and relatively untouched environment.

While most science activities are small in scale, in combination they contribute to cumulative impacts in and around Rothera. These impacts are assessed as no more than minor or transitory and are assessed by separate EIAs to the construction activities presented here.

12.5.2 New Footprint

The proposed installation of the new VLF hut on East Beach represents a footprint expansion for Rothera. Although there are some other science installations in the area, East Beach has traditionally remained free of infrastructure.

When the existing East Beach Hut was proposed in the 2021 *Rothera East Beach Hut IEE*[64], the identified cumulative impacts, which are still pertinent, included:

- the long-term use of the hut for scientific activity, including, use of electrical energy and associated emissions,
- on-going minor disturbance of wildlife and tramping of the very limited terrestrial biodiversity present at the site.
- A potentially more significant impact related to the opening up of East Beach to the construction of building infrastructure, where none had existed previously.
- Other potential projects, of possibly a larger spatial scale, may also be targeted for the East Beach areas, including the construction of wind turbines or the quarrying of rock for station modernisation projects.
- The potential cumulative impact upon the area's wilderness and aesthetic values could be substantial.

[64] https://www.bas.ac.uk/wp-content/uploads/2022/01/Rothera-East-Beach-Hut-IEE-FINAL.pdf

In addition, the investigation for the mooring point is also outside of the presently impacted area of Rothera, with the memorial cross and a small volume of science equipment at that location. If the proposed work proceeds this will also cause an expansion of the existing footprint with future construction, rock removal, and an access road/track required to install the mooring point.

As a second hut on East Beach the VLF hut is illustrating that there is potential for further erosion of the wilderness and aesthetic values. It cannot be overstated that the area around East Beach and the memorial cross are used by staff at Rothera as an escape from the activity on site, particularly the busy construction areas. So, these areas are important for welfare as well as biodiversity. Increasing use of these areas will add to the cumulative impacts of station footprint, and erosion of wilderness values.

The proposed impacts in this IEE for both the VLF hut and investigations for the proposed mooring point are no more than minor or transitory. However, if the mooring point construction goes ahead in the future this will need to be reassessed through a further EIA.

12.5.3 Atmospheric Pollution

By its very nature atmospheric pollution is persistent and widespread. While mitigation measures are in place to reduce the amount of emissions for Rothera works, the very nature of heating, vehicle use, aircraft operations and generators, mean that emissions are produced.

These emissions will rise into the atmosphere and join other pollutants from across the globe. Some evidence may be seen as particulates on the ice ramp however gases will travel out of the area.

The activities in the IEE require additional personnel to be on site and for Rothera to operate at maximum capacity. There will also be additional personnel on station through the winter period, potentially requiring additional heating and living areas to be occupied.

In addition to the activities in this IEE, and the supporting power generation via contractor generators, BAS and international aircraft movements, day to day heating and life support functions will be cumulative at the location.

Emissions could be caused by:

- Generators
- Vehicles
- Paints
- Incinerator
- Heating systems
- Refrigeration
- Reverse osmosis
- STP operation (power)
- Dust

The impact of the emissions associated with this IEE are considered to be no more than minor or transitory.

12.6 Future Activities

It is harder to assess future activities as they are not fully scoped, and timelines are unknown. However, the following have been discussed as being part of AIMP.

Table 12-2: Future Rothera activities, as at time of writing

Name of Proposed EIA	Proposed Activities/location
Renewables	Potential for installation of Solar PV, air source heat pumps, wind turbines, and associated batteries and infrastructure – potentially away from living quarters, so exploring 'new' areas, and areas where science instrumentation is currently the primary use.
Rothera Hangar	Potential for expansion of building, and diversion of stream. Bringing jaw crusher to site to access previously blasted rock that it too large for a cone crusher.
Mooring Point	Potential for new track/road to be constructed of the memorial cross area, and drilling/blasting/removal of rock, to house anchors. Permanent access/solutions will be needed to tie off ships.
Runway Extension	Potential for the runway length to be increased by infilling the sea at the end of the current runway.
Potential Radar Hut on East Beach	Potential for a new radar hut to accommodate science equipment, on East Beach with the East Beach hut and VLF hut.

Once installed the potential radar hut on East Beach would require power, which potentially will be accommodated by the new cable used for the VLF hut proposal. However, increasing infrastructure on East Beach will potentially continue to erode the wilderness value of that area.

There is also potential for increased ship traffic, and associated releases in the region of Rothera to impact the shoreline and marine environment. Other nations also have stations in the region, and it is not yet known what they may be considering for future works.

12.7 Cumulative Impact Assessment

The activities detailed above, and the proposed works assessed as part of this IEE, have the potential to have a cumulative impact. The impacts listed below associated with concurrent activities taking place at Rothera are those which are not considered to have been assessed in previous IEEs and are not explicitly referenced within this 2024-2025 and 2025–2026 Seasons IEE:

- Increased GHG emissions and particulates;
- Increased noise disturbance to local fauna;
- Increased dust generation;
- Increased quantities of waste generated during a single season, putting a strain on waste processing resource, including incineration of human waste generated off-site. Waste generation also implies the unnecessary use of materials which have been transported to Rothera and must be removed as waste;
- Increased use of stockpiled material and movement of material around Rothera;
- Increased light pollution through the use of artificial lighting;
- Increased physical presence and use of space resulting in disturbance to operations and science activities;
- Increased footprint and ground disturbance;
- Increased risk of fuel or hazardous substance release, adding to unrecovered hazardous substance releases already on site and covered in past PSER;
- Increased risk of disturbance to native flora and fauna;

- Increased sewage discharge; and
- Increased temporary visual impacts to Rothera due to increased concurrent activities.

The mitigation and monitoring measures proposed for the works, alongside the standard operational procedures at Rothera, are considered to be sufficient to manage the environmental impacts associated with the potential cumulative effects listed above.

Potential long-term cumulative impacts include disturbance to native flora and fauna, through continuous noise and vibration disturbance, light pollution, and dust emissions. Monitoring is in place for this purpose to ensure levels are not exceeded during construction seasons and over time, however it must be noted that in the past season it has not been reliable and steps have been taken to remedy this including dedicated environmental resource at Rothera; should significant effects on a particular species be observed, for example through a reduction in skua breeding activity at Rothera, works will be ceased while a management plan is agreed and implemented.

The scope of works associated with this IEE are such that wholescale changes in operational patterns or behaviours as a result of new infrastructure are not anticipated, beyond those that have been assessed as part of this IEE. At the appropriate time for assessment, when sufficient detail is known, future AIMP phases and activities will incorporate cumulative effects associated with any ongoing works at Rothera and their interaction with the scope of works for that particular season. Impacts would be assessed individually and cumulatively, and mitigation measures put in place to reduce impacts where necessary.

To ensure the impact on day-to-day operations of Rothera is minimised, the demand on space and laydown areas will need to be managed effectively across the AIMP projects and business as usual. The implementation of the Rothera Station Integration Plan (RSIP) will be essential if the planned operational and science delivery is to continue unaffected.

12.8 Summary

In summary, the proposed AIMP activities as set out in this IEE have the potential to add to cumulative impacts at Rothera Research Station over the 2024-25 and 2025-26 seasons.

The identified and predicted cumulative impacts would potentially result in:

- Loss of ice-free ground for terrestrial habitat;
- Dust deposition on the ice ramp, and around station;
- Removal of rock or change of topography, resulting in change of aesthetics;
- Loss of marine habitat as footprint increases, or substances are released to the sea;
- Contribution to global atmospheric pollution.

All proposed and as yet unknown activities in and around the Rothera location will interact with past, current and future activities to degrade the marine and terrestrial habitat, create emissions, create noise and erode wilderness and aesthetic values of the Antarctic environment.

When considering the cumulative impacts of the activities proposed in this IEE they are assessed as having no more than minor or transitory impacts.

13. MONITORING AND AUDIT REQUIREMENTS

13.1 Monitoring

Article 5 of Annex I to the Environmental Protocol explicitly requires appropriate monitoring of key environmental indicators to be put in place to assess and verify the predicted impacts following completion of a CEE. It states that monitoring needs to "be designed to provide regular and verifiable records of the impacts of the activity" (Article 5(2)) and to "provide information useful for minimising or mitigating impacts, and, where appropriate, information on the need for suspension, cancellation or modification of the activity" (Annex I, Article 5, (2) (b) Environmental Protocol, 1991). Provision should also be made for regular and effective monitoring to be in place to facilitate early detection of possible unforeseen effects of activities (Article 3 (2) (e) Environmental Protocol, 1991). Monitoring is being undertaken for this IEE to allow assessment of the impacts of ongoing activities, including the verification of predicted impacts and to facilitate early detection of the possible unforeseen effects of activities.

Information within this section of the IEE has been taken from the RUNSUR IEE (2022) and the BAM Environmental Monitoring Proposal, as well as monitoring proposals which have been recommended throughout this IEE for the 2024 - 2025 and 2025 - 2026 Seasons.

To monitor the impacts of construction on noise, vibration, and dust pollution due to the AIMP works, environmental monitoring has been taking place as part of the AIMP construction projects at Rothera since the Wharf reconstruction began in 2018. If monitored variables are found to exceed thresholds as set out later in this section, a report must be made to the BAS Environment Office within 24 hours and mitigation must be put in place to reduce the environmental impact of the activity. Where thresholds are exceeded, and further mitigation measures are required, this is incorporated into any future works to ensure greater compliance with the Environmental Protocol.

13.2 Existing Monitoring Arrangement

The current monitoring arrangement comprises four monitoring locations which each measure noise, vibration, and dust. The positioning of these monitors has considered the proposed and potential projects during Phase 2 of the AIMP, reflecting on lessons learned from previous seasons, as well as the latest information regarding sensitive receptors, particularly those that are part of the natural environment of Rothera.

Monitoring of noise, vibration and dust currently takes place at four locations:

1. Moss Patch – at the moss patch monitoring location;
2. Bonner Laboratory – close to potential quarry locations to ensure scientific work can continue undisturbed by vibrations;
3. Ice Ramp – to allow monitoring of works to the runway; and
4. ASPA – to monitor this control area.

Monitoring tasks are split into three types of activities as described here:

1. Short term monitoring of activities which could result in an immediate impact on the environment and can be modified during the programme of works to avoid adverse effects. This will include monitoring of the following:
    - Wildlife displacement;
    - Moss patch condition;
    - Neutralisation of cement and grout contaminated waters;
    - Noise from various activities; and
    - Airborne dust.

2. Monitoring of environmental parameters which may reflect impacts that can only be measured in the long term (i.e., over several Antarctic seasons) and subsequently are unlikely to be modified beyond the original mitigation identified in the EIA. This will include monitoring of skua breeding success on Rothera.
3. Environmental management activities – BAM will undertake these as indicated in Table 13-1.

Table 13-1 Environmental Management Activities

Environmental Management Activity	Location in EIA	Reporting Output
Waste Management: segregation, packaging, storage, and disposal of waste as per the SWMP and BAS WMH	Section 7.5 and Appendix 1	• Waste Transfer notes • Waste Quantity and Type data
Biosecurity: implementation of the Biosecurity Plan at all stages of cargo and personnel movement	Section 7.6 and Appendix 3	• Biosecurity checklists • Biosecurity breaches reported
Fuel Management: daily refuelling as per refuelling procedure	Sections 7.1 and 6.3	• Staff training records • Fuel spill reporting • Fuel consumption for carbon accounting
Oil Spill Response: BAM will provide appropriate spill response equipment	Section 7.3	• BAM staff will respond to Tier 1 spills and follow the direction of Rothera Station Leader for all Tier 2 and Tier 3 spills. • Fuel spill reporting • Spill kits used and disposed of appropriately

13.3 Proposed Monitoring Arrangement

Monitoring locations will remain the same for the 2024-2025 and 2025-2026 Seasons at the four locations all measuring noise, vibration, and dust. The positioning of these monitors has not been changed as the nature of Phase 2 works remains spatially consistent with previous seasons.

In addition to environmental monitoring, additional information is required to be recorded, including:

- BAS Energy and Carbon Dashboard data collection for:
  - The increased contribution to atmospheric pollution from the deployment of personnel and cargo;
  - Fuel use during construction; and
  - Waste statistics for future monitoring and assessment purposes.

Following issues with monitors in the 2023-2024 Season, a number of actions have been taken to improve the environmental monitoring on site during the 2024-2025 and 2025-2026 Seasons:

- Monitoring equipment will be inspected to ensure no signs of malfunction and recalibrated in the UK prior to deployment to Rothera and would remain in place throughout the 2024 - 2025 and 2025 - 2026 Seasons;
- All four monitors will be set up in the UK for trialling during the pre-season with the BAM Environmental Management staff who will be on station during the Seasons; and
- Additional environmental resource on site will ensure that exceedances, as well as other environmental issues, are properly reported and addressed.

The latest BAM programme states that monitors will be installed and operational on-site following snow clearing between 4th - 16th November, which is considered to be the earliest date that monitors can be installed. Resource constraints at the start of the season often mean that monitors are not fully installed when anticipated. Snow clearance is considered to take a priority on site and is required in order to access locations to install the monitors. It should be noted that this target date is dependent on the amount of snow found on site.

If excessive snow is found on site at the start of the season, additional snow clearing will be required. As a worst-case, monitors are anticipated to be set up and operational at all four locations by the end of November each season.

Works anticipated to be undertaken in the early weeks, prior to monitor set-up, are anticipated to be site-set up and snow clearance activities and are not considered likely to result in any noise, vibration, or dust exceedances; the absence of monitoring during this initial period is not considered to result in significant impacts. Section 14 discusses the uncertainties around monitoring in more detail.

No maintenance is anticipated to be required on site for the duration of the monitoring period.

13.3.1 Wildlife Displacement

Monitoring type and purpose	Recording of wildlife displacement such as encouraging seals and penguins to move safely away from areas where work is being undertaken or within designated vehicle access routes.
Description	Records must be kept of all wildlife displacement events involving seals and penguins. Such events may include the movement of seals or penguins to allow the site to be secured (to enable, for example, building work to commence) or for vehicle movement around Rothera.
Methodology	All those involved in the relocation of wildlife must have undergone training at Rothera by BAS management. All works to adhere to the Wildlife Interaction Manual, Appendix 4. No bird nest sites are to be moved or physically disturbed by individuals or machinery Visual observations and recording of species displaced. Thresholds for displacement: • more than five seal displacement events per day; OR • More than five penguin displacement events per day.
Duration of monitoring	Recording to be undertaken during the full construction period (when BAM present on site)
Frequency	As required. Displacement events must be recorded following every occurrence.
Actions should thresholds be exceeded	BAM shall contact the BAS Environment Office within 24 hours to discuss the feasibility of mitigation measures should thresholds be exceeded
Recording and management of data	For each displacement event the following information shall be recorded: • Number, type and maturity of displaced seals (if known); • Reason for displacement; and • Location of displacement event and where the wildlife was moved to.
Method of communication to the BAS Environment Office	Monitoring data to be presented to the BAS Environment Office every two weeks unless thresholds are exceeded as part of the BAM Monitoring and Reporting Schedule, and in a final report submitted at the end of each season. Any wildlife injury or fatality associated with the work should be reported immediately to the BAS Environment Office and reported in the BAS Incident Reporting System (Maximo).

13.3.2 Moss Patch

The moss patch will be monitored at monthly intervals through photographic records to monitor any impact during construction activities. Photographs must be taken from the same vantage point to allow comparison of the moss patch throughout the Season.

13.3.3 Neutralisation of Cement and Grout Contaminated Waters

Monitoring type and purpose	Measurement of the pH of cement and grout contaminated water, to ensure only pH neutral water is discharged to the ground.
Description	Use of cement and grout may produce wastewater that is strongly alkaline. Before release to the ground, the wastewater should be neutralised using citric acid.
Methodology	A pH meter will be used to ensure wastewater is neutral before it is discharged to the ground.
Duration of monitoring	Monitoring only needs to occur during the period of cement use and when wastewater is generated e.g., when equipment is cleaned.
Frequency	During period of neutralisation of cement contaminated wastewater, and immediately prior to subsequent disposal.

Actions should thresholds be exceeded	Should the pH not be reduced to pH 7, the wastewater will not be released until the required pH is achieved.
Recording and management of data	For each water release event, the following information will be recorded and reported to the BAS Environment Office: • The volume of neutralised water released to the environment; • The pH of the water.
Method of communication to the BAS Environment Office	Monitoring data to be presented to the BAS Environment Office every two weeks unless thresholds are exceeded as part of the Monitoring and Reporting Schedule, and in a final report submitted at the end of each season. Should any wastewater be released to the environment that has not been adequately neutralised (pH 7) then the BAS Environment Office shall be informed immediately, and it will be reported on Maximo.

13.3.4 Noise

Monitoring type and purpose	Excessive noise may cause disturbance and potential injury to local wildlife and needs to be monitored to ensure thresholds are not exceeded.
Description	Before commencing noisy activities and the use of noisy equipment, consideration should be given to the impact upon wildlife. Animals on land are likely to move away from the noise source at the commencement of the activity. Monitoring will occur at sites around Rothera, to estimate noise generation by construction activities, rock crushing and grading and plant operation and movement. Previous noise assessments have demonstrated that noise levels at this limit are unlikely to cause temporary or permanent damage to the hearing of the wildlife at Rothera. Disturbance of wildlife from noise at these limits cannot be assessed due to lack of available research.
Methodology	Noise shall be monitored at: • Moss Patch; • Bonner Laboratory; • Ice Ramp; and • ASPA. Noise will be sampled at 51.2 kHz and reported each minute. Two limits have been set for noise levels: • LAeq 12 hour (the equivalent average noise over the 12-hour working period) < 75dB; and • LAeq 1 hour (the equivalent average noise over a 1-hour period) < 80dB. The 12-hour limit of 75dB is derived from BS 5228 Part 1 - Code of practice for noise and vibration control on construction and open sites. Appendix E of the standard discusses the significance of noise effects. Section E.2 states “Noise levels, between say 07.00 and 19.00 hours, outside the nearest window of the occupied room closest to the site boundary should not exceed: • 70 dBA in rural, suburban, and urban areas away from main road traffic and industrial noise; and • 75 dBA in urban areas near main roads in heavy industrial areas. As Rothera features a runway, it was decided that the limit of 75 dBA was more applicable to the site. Noisy activities will be scheduled to occur sequentially and not simultaneously to reduce noise levels.
Duration of monitoring	Recording to be undertaken continuously during the construction period, ideally during set-up and eventual site demobilisation (when BAM present on site)
Frequency	Continuous monitoring, real time reporting
Actions should thresholds be exceeded	Activities related to vehicle movement and construction must cease and noise management measures be reassessed.
Recording and management of data	Monitors to be hard wired into BAS IT system and transferred via VLAN. Provision for manual data collection to be retained for early season data capture

Method of communication to the BAS Environment Office	Monitoring data to be presented to BAS on a fortnightly basis unless a threshold exceedance has been recorded. If a threshold is exceeded this is required to be reported to the BAS Environment Office within 24 hours of the incident occurring. The regular noise monitoring reporting is part of the BAM Monitoring and Reporting Schedule, when noisy activities have occurred, and in a final report submitted to the BAS Environment Office at the end of each season. Raw data files must be made available. Should mitigation measures and practices be insufficient to keep noise levels below the threshold, contact must be made with the BAS Environment Office at the earliest opportunity to discuss further options.

13.3.5 Vibration

Monitoring type and purpose	Vibration will be monitored to ensure levels do not significantly impact upon local wildlife.
Description	Monitoring of vibration from activities (e.g., vehicle movement) shall be done to ensure local receptors are not impacted above threshold levels. Monitoring will occur at sites around Rothera, as outlined within this section of the report, to estimate vibration generation by construction activities, rock crushing and grading and plant operation and movement.
Methodology	Vibration from construction activities will be monitored using triaxial accelerometers. Vibration shall be monitored at: • Moss Patch; • Bonner Laboratory; • Ice Ramp; and • ASPA. The lack of research on the effects of vibration on animals means that no specific limit of vibration can be set for animal receptors, although data is available for the effects of vibration on humans and these limits are applied to manage effects to wildlife. Measurements of human exposure to vibration expressed as VDVs combine the magnitude of vibration and the time for which it occurs and are measured in $ms^{-1.75}$. BS 6472 - Guide to evaluation of human exposure to vibration in buildings provides guidance on how vibration is perceived by humans in residential buildings, offices, and workshops. Rothera feature all three building types assessed. BS 6841 - Measurement and evaluation of human exposure to whole-body mechanical vibration and repeated shock states that vibration dose values in the region of 15 $ms^{-1.75}$ will usually cause severe discomfort. Based on the above information, a limit of 2.4 $ms^{-1.75}$ is proposed for VDV, representing the level at which adverse comment is probable in workshops during daytime. DIN 4150-3 Effects of Vibration on structures proposes three vibration limits, depending on the building assessed. These limits depend on the frequency of vibration as shown in Figure 13-1. This standard is regularly used when setting limits for vibration to protect structures and items within them. From the perspective of ensuring no damage to existing buildings occurs, L2 Residential Buildings would be a suitable limit for Rothera. Therefore, vibration levels measured as PPV should not exceed the values outlined in DIN 4150-3 Effects of Vibration Line 2.
Duration of monitoring	Recording to be undertaken continuously during the full construction period (when BAM present on site)
Frequency	Continuous monitoring, real time reporting
Actions should thresholds be exceeded	Activities must cease and vibration management reassessed. If thresholds are exceeded, activities likely to produce substantial vibration should not be undertaken simultaneously, but rather rescheduled to occur sequentially and thereby reduce the total level.
Recording and management of data	Monitors to be hard wired into BAS IT system and transferred via VLAN. Provision for manual data collection to be retained for early season data capture
Method of communication to the BAS Environment Office	Monitoring data will be presented to BAS on a fortnightly basis unless a threshold exceedance has been recorded. If a threshold is exceeded, this is required to be reported to the BAS Environment Office within 24 hours of the incident occurring. A full summary of the monitoring data must be presented to the BAS Environment Office in a report submitted at the end of each season. The raw data files must also be made available.

	Should mitigation measures and practices be insufficient to keep vibration levels below the threshold, contact must be made with the BAS Environment Office at the earliest opportunity to discuss further options.

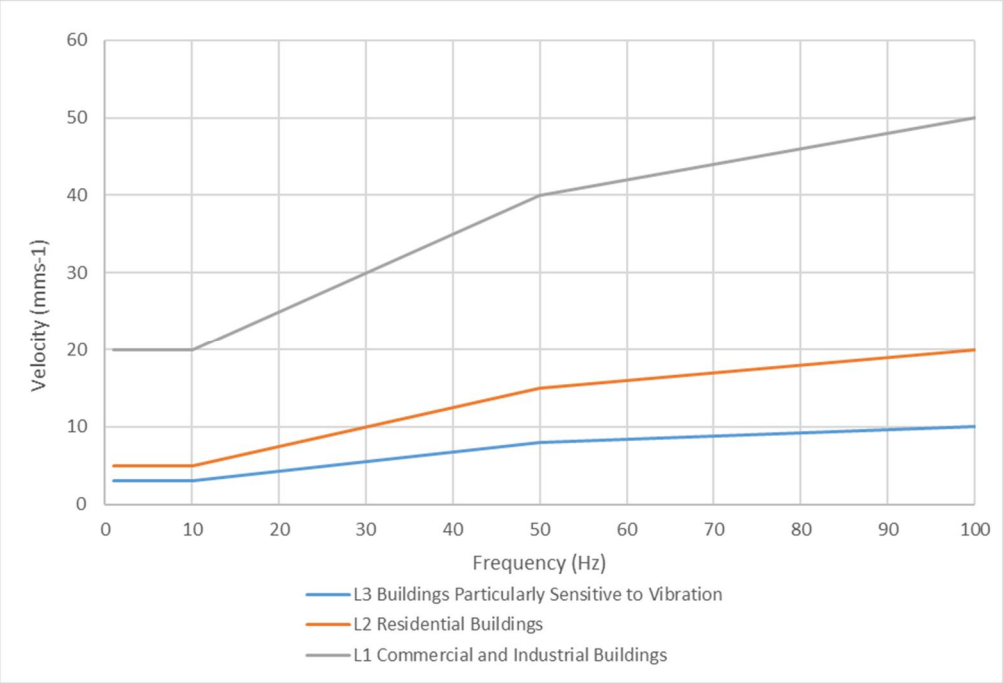

Figure 13-1 Guideline limits for vibration velocity with respect to vibration

13.3.6 Dust

Monitoring type and purpose	Dust and particulate deposition may have adverse impacts upon the melting rate of the ice ramp, the small areas of vegetation present on Rothera and the breathing of personnel.
Description	Monitoring of dust will be undertaken to ensure excessive generation is avoided for the duration of the construction process.
Methodology	UK and EU air quality standards concentrate on smaller particles, which are known to have greater effects on human, and therefore animal health. Based on the UK and EU air quality limits, a PM^{10} limit of 50µg/m^3/24 hours is proposed. Although an additional expense, it is also proposed that the monitoring of TSP continues for a least one season to compare future dust volumes to past concentrations. It is also more applicable to the smothering of vegetation. The current limit for TSP is 250µg/m^3/15 minutes. The two different particle sizes can be monitored using a single instrument with an additional filter. $PM^{2.5}$ and PM^{1} will also be monitored, but there are no agreed limits.
Duration of monitoring	Recording to be undertaken continuously during the full construction period (when BAM present on site).
Frequency	Continuous monitoring, real time reporting
Actions should thresholds be exceeded	Dust suppression strategies will be investigated to reduce dust levels associated with construction activities.
Recording and management of data	Monitors to be hard wired into BAS IT system and transferred via VLAN. Provision for manual data collection to be retained for early season data capture
Method of communication to the BAS Environment Office	Monitoring data will be presented to BAS on a fortnightly basis unless a threshold exceedance has been recorded. If a threshold is exceeded, this is required to be reported to the BAS Environment Office within 24 hours of the incident occurring. A summary of the monitoring data must be presented to the BAS Environment Office in a report at the end of each season. The raw data files must also be made available. Should mitigation measures and practices be insufficient to keep dust levels below the threshold, contact must be made with the BAS Environment Office at the earliest opportunity to discuss further options.

13.3.7 Skua Breeding Success on Rothera

Monitoring type and purpose	Skua breeding success on Rothera.
Description	Nesting skua populations on Rothera may be vulnerable to disturbance associated with the proposed works. Ongoing monitoring work to assess the impact of construction activities on skua breeding success will be maintained. BAS routinely undertake monitoring of skua breeding success as part of long-term monitoring commitments
Methodology	Breeding parameters that will be recorded include: • Laying dates; • Clutch size; • Egg dimensions; • Hatching success; • Fledging success; • Chick condition; and • Adult attendance (an indicator of foraging effort). Monitoring includes re-sighting of colour-ringed adults which can be used as an indicator of adult survival, breeding frequency and divorce rates and to determine breeding histories of individuals and the effects of mate change. Monitoring of birds on Anchorage Island will provide a control data set.
Duration of monitoring	BAS Bonner Laboratory Manager will undertake monitoring each summer (November to March) for each season.
Frequency	Weekly
Actions should thresholds be exceeded	Should any direct or indirect physical damage to birds or nest be noted, this will be communicated to the BAS Environment Office immediately and reported on Maximo.
Recording and management of data	Data are routinely recorded by the Bonner Laboratory Manager and submitted to the BAS Data Centre
Method of communication to the BAS Environment Office	A summary of the monitoring data must be presented to the BAS Environment Office at the end of each breeding season. Should any physical damage to birds or nests be noted, this will be communicated to the BAS Environment Office immediately and reported on Maximo.

13.4 Data Collection and Reporting

Dust, noise and vibration monitors are hardwired to Rothera's local area network (LAN) to provide real time data. To allow BAS and BAM to fully understand the cause of any exceedances, which can then be actioned to mitigate the potential environmental impact within a suitable time frame. The current system uses manual data collection which requires an individual to visit each monitor and download the data. A wi-fi system has been trialled at Rothera however it was not possible to gain a reliable data connection.

The inability to gain real time data means that the possibility to attribute exceedances to individual events and address them in a timely manner is limited. It is considered important to explore the possibility of a live feed to BAS in Cambridge, UK, further, to better distinguish between when a severe construction exceedance occurs versus errors in monitoring. The ability to consistently monitor exceedances over the season will ensure compliance with future IEEs is possible.

13.5 Audit Programme

An environmental audit programme will be undertaken during the construction works by the site supervisor to ensure that the actions and mitigation measures committed to in this document are being adhered to. This will follow a BAS Environment Office approved checklist.

The audits will be conducted against the ISO14001:2015 standard to which BAS is registered. Updated audit proformas are currently being produced. A minimum of two onsite audits will be undertaken during each season and a further EIA review which will include a site visit to Rothera will be undertaken on completion of the works.

Any changes to activities proposed as a result of the monitoring data, will be made by the Construction Manager in conjunction with the BAS Environment Office. All monitoring data will be communicated to the BAS Environment Office and be available on request for auditing purposes.

13.6 Summary of Actions and Commitments

This section summarises the actions and commitments presented within this IEE to ensure that mitigation and mitigation owners are clearly communicated and can be used as part of the auditing process.

The actions and commitments presented in Table 13-2 are considered to have been confirmed by all parties.

Table 13-2 Summary of Actions and Commitments

IEE Section	Agreed Actions, Mitigation and/or Monitoring Measures	Owner
4: Methodologies	Specialist Activity Permits will be sought for all activities where required	ATC
Atmospheric emissions mitigation and monitoring	Before procuring new equipment for the project, ensure that all options for repair/re-use/loan of existing equipment have been considered	BAM/BAS
	Ensure that all operations at Rothera are as efficient as possible to reduce excess fuel use	BAM/BAS
	Generators and plant will be selected which balance efficiency and reduced emissions, with reliability, serviceability, and available fuel at Rothera	BAM/BAS
	Incorporate clean energy sources into site-wide electricity use and thermal generation, where possible – e.g. the new PV solar panels mounted on Discovery Building.	BAM
	Regular inspection and maintenance will be carried out to ensure all vehicles, plant and generators operate efficiently, as per the BAM PMP	BAM
	Where practical, all drivers will be instructed to turn off engines during periods of waiting for 15 minutes or more	BAM
	Rationalisation of plant and equipment shipped to Rothera will be undertaken	BAM/BAS
	Only staff essential to the proposed works will be deployed to Rothera	BAM/BAS
	Rationalisation of plant and equipment shipped to Rothera will be undertaken	BAM/BAS
	All staff will be briefed on energy efficiency whilst at Rothera as part of the pre-deployment training	BAM/BAS
	Only staff essential to the proposed works will be deployed to Rothera.	BAM/BAS
	Data will be collected and the increased contribution to atmospheric pollution from the deployment of personnel and cargo will be accounted for in the BAS Energy and Carbon Dashboard	BAM/BAS
	Good programme resource management will be applied across project activities to mitigate overall duration impact – e.g. efficiency of vehicle uses on construction activities; and apply minimal energy use during winterisation between seasons	BAM/BAS
	Movement of materials, such as stockpile use, will be recorded to maintain up to date record of remaining material quantities and avoid the need for additional trips at Rothera and/or cargo trips	BAM/BAS
	Incineration of waste is to be minimised, as far as is reasonably practicable	BAM/BAS
	If available, use alternative fuels to reduce emissions	BAM/BAS
	Fuel use during construction will be recorded and reported in the BAS Energy and Carbon Dashboard	BAM/BAS
Noise and vibration emissions mitigation and monitoring	All vehicles to maintain a 10-mph speed limit on site, enforced as standard procedure at Rothera	BAM/BAS
	Plant items will be positioned to ensure exhaust outlets point away from sensitive receptors	BAM/BAS
	Regular maintenance of all plant and vehicles to ensure they are working efficiently and generating as little noise as possible	BAM/BAS
	A slow-start procedure (gradually increasing noise over a period of time) will be implemented for all noisy construction equipment to give animals on land, except nesting birds, the opportunity to move away from the noise source before it reaches its highest levels	BAM/BAS
	Consideration of the impact of noisy activities to all wildlife in the vicinity will be given	BAM/BAS
	If agreed noise and/or vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening	BAM/BAS
	If agreed vibration levels are exceeded, works in that area will cease until additional mitigation measures can be implemented	BAM/BAS
	Where programming and resource allows, works to be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-cumulative noise impacts	BAM/BAS
	The transportation of personnel or cargo will take the most optimal route to minimise potential impacts on marine mammals.	BAM/BAS
	Continuous noise monitoring will take place at Rothera to ensure noise levels do not exceed agreed levels of 75 dBA equivalent 12-hour and 80 dBA equivalent 1-hour, which could cause adverse impacts to local fauna (notably seals and birds).	BAM
	Continuous vibration monitoring will take place at Rothera to ensure vibration dose values (VDV) do not exceed 2.4 $ms^{-1.75}$ and vibration levels measured as Peak Particle Velocity (PPV) do not exceed the values outlined in DIN 4150-3 Effects of Vibration Line 2.	BAM
	Skua monitoring will continue throughout the construction programme, as well as the SI Works and Condition Surveys, to obtain updated information on nest activity that can be used to inform any additional mitigation methods and future AIMP works. Particular attention will be paid to the skua nest locations during and after works are complete.	BAM
Dust emissions mitigation and monitoring	For activities likely to produce high levels of dust, dust suppression equipment should be used and/or roadways should be damped down with seawater, when required.	BAM
	Where practicable, activities which are anticipated to generate dust are to be kept downwind of sensitive receptors and are not to be undertaken in close proximity to known vegetation or ice locations.	BAM/BAS
	All routes used by vehicles and plant will be well maintained and have compacted surfaces	BAM/BAS
	Limit the drop height of materials during stockpiling, processing, and loading operations	BAM/BAS
	Minimise double handling of materials to reduce the overall number of tipping actions	BAM/BAS
	All vehicles to maintain a 10-mph speed limit on site, enforced as standard procedure at Rothera	BAM/BAS
	All plant and equipment to be maintained on a regular basis, as per the BAM PMP	BAM

IEE Section	Agreed Actions, Mitigation and/or Monitoring Measures	Owner
	All cement mixing will be carried out in accordance with the method statement and cement will not to be mixed externally on windy days, as advised by the Site Manager and Rothera Station Leader	BAM
	If agreed dust levels are exceeded, works in that area will cease until additional mitigation measures can be implemented	BAM/BAS
	The Meteorological Team will provide a weather forecast to the Site Manager every morning. This will be reviewed by the Site Manager in conjunction with the Rothera Station Leader to inform the decision on which activities can proceed that day and if any activities need to be suspended or additional mitigation measures put in place. During excessively dry, windy conditions, especially where the wind direction will blow dust towards sensitive receptors, it may be necessary to temporarily suspend operations, for example incineration of waste, if it is not possible to control dust by other means	BAM/BAS
	Continuous dust monitoring will take place to ensure dust levels do not exceed agreed levels. A PM_{10} limit of 50µg/m^3/24 hours is proposed and a total suspended particle (TSP) limit of 250µg/m^3/15 minutes.	BAM
	Wind level data to continue to be captured from the Met Mast by the Met team every morning. The Met team will provide a weather forecast to the BAM project manager who will assess the impacts of wind on dust generating activities and apply mitigation as required.	BAM/BAS
Waste mitigation and monitoring	The SWMP will be strictly adhered to for all construction waste	BAM
	The storage of waste streams shall be segregated for recycling, re-use, or recovery at a dedicated area for the storage of waste, in accordance with the SWMP. Segregation of waste will allow consolidation of packing, thus reducing volumes required for shipping back to the UK	BAM
	The waste hierarchy will be applied	BAM/BAS
	The packaging of materials / supplies will be minimised where reasonably practicable prior to the consigning of cargo to Antarctica	BAM/BAS
	Import of raw materials will only be undertaken where necessary, and in quantities required to avoid surplus material	BAM/BAS
	Waste to be stored in the appropriate storage method	BAM
	Daily checks to ensure waste is contained to avoid being blown around site	BAM
	Provision of a BAM staff member dedicated to environmental management who will ensure that all waste is managed appropriately	BAM/BAS
	All construction waste is to be returned to the UK and disposed of by the appointed licensed contractors	BAM/BAS
	BAM has a commitment to achieving an 80% diversion of construction waste from landfill and a 90% diversion of all waste from landfill (Project specific targets may vary)	BAM
	Any waste materials deemed to be in good condition will be offered to the Station Leader for potential re-use	BAM/BAS
	Pre-deployment training on waste management for all operatives	BAM/BAS
	All team members are to read and be briefed on the ‘Field Operations Manual’ relating to Environmental Management and the BAS Waste Management Handbook	BAM/BAS
	Human waste generated off-site (e.g. during the transportation of personnel) will be incinerated at Rothera, otherwise all human waste shall be treated and discharged via the STP.	BAM/BAS
	All toilets and washing facilities are connected to the foul drainage system and will discharge via the STP	BAM/BAS
	Any cementitious or grout wash waters produced during construction will be neutralised to a pH of 7.0 using citric acid prior to discharge to ground. Cementitious and grout materials are mixed in the BAM Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the BAM Fitters Workshop	BAM
	Domestic water system sterilisation to follow relevant contractor procedures. Excess wastewater containing hydrogen peroxide drawn through tap outlets to be captured in holding tanks, to allow hydrogen peroxide to naturally dissipate in water over 24 hours	BAM/BAS
	The loss of any equipment will be reported in Maximo	BAM/BAS
	UV will be irradiated at the STP prior to discharge to mitigate the impact of the discharge	BAM/BAS
	Waste statistics will be collated for future monitoring and assessment purposes	BAM
	Neutralised water monitoring and recording	BAS
	Continuous review of opportunities to improve efficiency of water usage STP operations	BAM
External light emissions mitigation and monitoring	The proposed activities will be undertaken during daylight hours as far as reasonably practicable, and the intensity and use of lighting will be minimised during low light hours.	BAM/BAS
	In the instance when lighting rigs are to be used, they will be positioned angled towards the ground and not horizontally.	BAM/BAS
	When not in use lights are to be turned off and where possible external lighting should incorporate movement sensors or similar technology to minimise the during of illumination.	BAM/BAS
	In the event of a bird strike, a suitably trained bird strike response staff member will take charge of the bird’s care in accordance with the BAS Wildlife Interaction Manual.	BAM/BAS
	Lights to be switched off immediately if more than five bird strikes occur in one period of works	BAM/BAS
	All bird strikes will be recorded on Maximo and immediately reported to the BAS Environment Office.	BAM/BAS
Physical presence and use of space mitigation and monitoring	All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE.	BAM/BAS/Ramboll
	Changes to the locations used for any activities are to be agreed with BAS Operations, the BAS Environment Office and FCDO.	BAS Operational Team, BAS Environment Office and BAM

IEE Section	Agreed Actions, Mitigation and/or Monitoring Measures	Owner
	Evacuation plans will be agreed with station management to ensure appropriate safe evacuation occurs with minimal disturbance to day-to-day activities on site.	BAM/ BAS
	The BAS Project Support Coordinator will prepare a Rothera Station Integration Plan (RSIP) to demonstrate adequate space use on site for the proposed activities.	BAM/BAS
	Pre-deployment training sessions to be held with all BAM and BAS staff.	BAM/BAS
Physical or mechanical disturbance on land mitigation and monitoring	All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE	Ramboll
	Changes to the locations used for any activities are to be agreed with BAS Operations, the BAS Environment Office and FCDO	Ramboll/BAS/BAM
	Minimise the footprint of all works through careful design	Ramboll/BAS
	All vehicles to maintain a 10-mph speed limit on site, enforced as standard procedure at Rothera	BAS/BAM
	Minimise material movements to and from stockpile locations	BAS/BAM
	Allocate a dedicated member of staff to maintain accurate stockpile records	BAS/BAM
	During replacement or decommissioning there will be an over-excavation of material to compensate for any potential localised movement of degraded plastic from ducting in the environment.	BAS/BAM
	Locate SI hand-digging from sensitive environmental constraints	BAM
	Demarcation of the ASPA for the prevention of vehicles, such as skidoos, into the environmentally sensitive area.	BAM/BAS
	Contractors to be briefed on the location of the Ice Ramp and the control measures in place when working adjacent to the Hangar (Control Point installation)	BAM/BAS
	If contamination is encountered during the borehole works, all equipment will be cleaned between trial holes to prevent cross contamination. Any occurrences of contamination should be reported to the Rothera Station Leader	BAM
	Daily checks on all routes used by construction vehicles	BAM
	Maintain accurate records of stockpile material volumes and movements	BAM
	Daily checks on all routes used by construction vehicles	BAM
	Monitoring and maintenance of runway surface repairs to ensure that surface remains in a safe and working condition.	BAM
Fuel or hazardous substance release mitigation and monitoring	Refuelling will be undertaken in accordance with the OSCP refuelling requirements at Rothera to ensure continual inspections are made of fuelling equipment and drip trays are placed under hose joints as a precaution - this procedure is reviewed annually	BAM/BAS
	Spill kits will be in all mobile vehicles and in well-defined and easily accessible locations on site.	BAM/BAS
	Plant nappies will be used for all static plant	BAM/BAS
	A core oil spill response team of a minimum of 24 station staff will be formed and receive pre-deployment oil spill response training. This training will be in addition to on-site training led by the BAS Environment Office and delivered by BAS and Oil Spill Response Ltd. This training is in addition to on-site training delivered by the Rothera Station Leader	BAM/BAS
	The OSCP will be followed for Tier 1, 2 and 3 spills	BAM/BAS
	De-winterising checks will be undertaken in accordance with the OSCP	BAM/BAS
	All plant will be inspected daily for potential leaks and condition of hydraulic oil hoses - these checks will be recorded on the daily plant check sheets and the daily activity plan compliance record	BAM/BAS
	All fuel storage tanks to be checked weekly and recorded on the BAM Environmental Inspection Checklist EC01, as current procedure	BAM/BAS
	Any cementitious or grout wash waters produced during construction will be neutralised to a pH of 7.0 using citric acid prior to discharge to ground. Cementitious and grout materials are mixed in the BAM Fitters Workshop and the wash water, once neutralised, will be discharged away from sensitive receptors to the west of the BAM Fitters Workshop	BAM/BAS
	All contaminated water resulting from LTHW systems flushing will be captured in IBCs, stored inside, and shipped back to the UK at the earliest opportunity	BAM/BAS
	Domestic water system sterilisation to follow relevant contractor procedures. Excess wastewater containing hydrogen peroxide drawn through tap outlets to be captured in holding tanks, to allow hydrogen peroxide to naturally dissipate in water over 24 hours.	BAM/BAS
	All spills reported to the Rothera Station Leader and BAS Environment Office	BAM, BAS Operations, BAS Environment Office
	The drilling management plan will be followed at all times during borehole works	BAM/BAS
	Safe drilling procedures to be followed at all times to reduce risk of loss of drill. Only experienced operatives will use the drill	BAM/BAS
	The updated WQMP is to be followed for post-commissioning plan for ongoing potable water sterilisation of the water systems	BAM/BAS
	The loss of any equipment will be reported in Maximo	BAM/BAS
Non-Native Species Introduction mitigation and monitoring	All personnel being deployed to Rothera will receive a pre-deployment briefing from a member of the BAS Environment Office which will cover biosecurity;	BAS
	All activities will be undertaken in accordance with the BAS Biosecurity Regulations, the CEP NNS Manual and the Project-specific Biosecurity Plan	BAM/BAS
	A trained manager will inspect all plant, equipment, and materials prior to loading onto the vessel and on disembarkation/offloading at Rothera	BAM/BAS
	All equipment and materials required for the proposed activities will be thoroughly cleaned before dispatch to Antarctica	BAM/BAS

IEE Section	Agreed Actions, Mitigation and/or Monitoring Measures	Owner
	The materials required for the new VLF hut will be treated prior to import to Rothera, including heat-treated wood.	BAM/BAS
	Should soil, seeds or propagules be imported unintentionally, they must be carefully collected and removed. Rodents and insects must be exterminated immediately	BAM/BAS
	The Rothera Station Leader and the BAS Environment Office must be informed immediately if a biosecurity incident occurs	BAM/BAS
	Evidence of the measures undertaken will be provided in the form of completed biosecurity audit checklists.	BAM/BAS
	Any biosecurity incursions will be reported immediately to the BAS Environment Office and on Maximo.	BAM/BAS
Disturbance to native flora and fauna mitigation and monitoring	All staff will receive pre-deployment and on-station briefings regarding wildlife viewing and working close to wildlife, ASPA and IBA	BAM/BAS
	All vehicles will be inspected, and wheels checked for the presence of seals and penguins before engines are started.	BAM/BAS
	In the unlikely circumstance of the displacement of seals or penguins, only trained personnel will be involved– the BAS Wildlife Interaction Manual will be referred to for any contact with wildlife.	BAM/BAS
	Someone suitably trained in wildlife interaction, as per the BAS Wildlife Interaction Manual, will be present at the start of works adjacent to any known nests to determine if they are inhabited at the time of works and to provide a final decision on when works can commence. Noisy works will not commence without express permission of the suitably trained person present.	BAM/BAS
	Where programming and resource allows, works to be programmed to avoid noisy activities occurring concurrently across projects, to avoid intra-cumulative noise impacts	BAM/BAS
	All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE	BAM/BAS
	Changes to the locations used for any activities are to be agreed with BAS Operations, the BAS Environment Office and FCDO	BAM/BAS
	The location of SI hand-digging at the East Mooring Point site will seek to avoid environmental constraints, as far as reasonably possible, and the SI field team will be accompanied by a BAS field guide during the duration of the works	BAM/BAS
	If agreed noise and/or vibration levels are exceeded during the Condition Surveys, works in that area will cease until additional mitigation measures can be implemented, such as acoustic screening.	BAM/BAS
	Checks of inactive skua nests to be undertaken prior to the commencement of any works nearby or behind the Hangar (survey control point installation), to confirm they remain inactive, as well as ongoing skua nest monitoring during the programme of works listed below.	BAM/BAS
	Demarcation of the ASPA for the prevention of vehicles, such as skidoos, into the area. The instructions will be passed on to relevant operatives before the transportation materials is undertaken for the new VLF hut.	BAM/BAS
	Contractors to be briefed on the location of the Ice Ramp and the control measures in place when working adjacent to the Hangar (Control Point installation).	BAM/BAS
	All vehicles will be inspected, and wheels checked for the presence of seals and penguins before engines are started	BAM/BAS
	Someone suitably trained in wildlife interaction will be present at the start of works adjacent to any known nests and noisy works will not commence without express permission of the suitably trained person present	BAM/BAS
	If drilling rigs for SI works are to be left in one location for an extended duration, they will be fitted with reflective tags in order to prevent bird collisions	BAM/BAS
	New solar monitoring masts installed will be fitted with reflective tags in order to prevent bird collisions	BAS
	The BAS Facilities team will maintain the demarcation of the no-go zone around the moss patch and ensure it is communicated to relevant personnel at Rothera	BAS Facilities Team
	Noise and vibration monitoring, as above.	BAM/BAS
	Dust monitoring, as above.	BAM/BAS
	Skua monitoring will continue throughout the Construction programme, as well as the SI Works and Condition Surveys, to obtain updated information on nest activity that can be used to inform any additional mitigation methods and future AIMP works. Particular attention will be paid to the skua nest locations during and after works are complete.	BAM/BAS
	Monitoring data to be presented to the BAS Environment Office every two weeks unless thresholds are exceeded as part of the BAM Monitoring and Reporting Schedule, and in a final report submitted at the end of each season.	BAM/BAS
	Any wildlife injury or fatality associated with the work should be reported immediately to the BAS Environment Office and reported in the BAS Incident Reporting System (Maximo).	BAM/BAS
	Any impacts to the moss patch will be monitored at monthly intervals through photographic records taken from the same viewpoint, implemented throughout the Rothera modernisation programme.	BAM
Visual impacts mitigation and monitoring	Construction activities will be confined to agreed areas on site. Any changes to the locations used by BAM will be discussed and agreed with the Rothera Station management team and where appropriate the BAS Environment Office and FCDO	BAM, BAS, Rothera Station management
	All activity methodologies and locations are to be undertaken in line with agreed methodologies and locations presented in this IEE	BAM/BAS
	Changes to the locations used for any activities are to be discussed and agreed with the Rothera Station management team and where appropriate the BAS Environment Office and FCDO.	BAM/BAS

14. GAPS IN KNOWLEDGE AND UNCERTAINTIES

14.1 Proposed Works

Exact timings of the works are not available for all activities, where these are not available assumptions have been made that these activities would take place within the season identified (2024-2025 or 2025-2026).

Any deviations to the information presented within this IEE will be accounted for within a Register of Project Variations; a live document that is actively managed and owned by BAS in close collaboration with BAM personnel in Rothera. Any variations will be reported in the PSER, along with a full complement of the monitoring data collected in support of the works that season.

As with previous seasons, the monitoring set-up at the start of the season requires snow clearance to take place before this can be undertaken. During the previous season, a set of sensors (4 No. dust monitors, 4 No. microphones and 4 No. vibration sensors) have been recalibrated. These all showed no signs of malfunction. However, due to the delay in monitoring equipment being set up, all four monitors will be set up in the UK for trialling pre-season, with the BAM environmental management staff who will be on station within the season in attendance. Additional environmental resource on site will ensure that exceedances, as well as other environmental issues, are properly reported and addressed. Monitors will be installed and operational on-site following snow clearing between the 4th and 16th November. It should be noted that this target date is dependent on the amount of snow found on site. If excessive snow is found on site at the start of the season, additional snow clearing will be required and we expect the 30th November to be the latest date the monitors will be installed and operational, prior to construction works commencing. The delay in monitoring equipment set-up is not considered to be acceptable, a minor risk is presented should monitoring not be established prior to the commencement of snow clearing activities. Monitoring must be established prior to construction activities commencing, otherwise this presents a major risk to environmental monitoring at Rothera. Ideally, monitoring is established at the start of every season for consistency in data reporting and to provide robust information on likely causes of exceedances.

The HANGAR SI boreholes have been included and assessed within this IEE as contingency as there is the possibility that they will not be undertaken. As the HANGAR SI activity will be required to understanding the deep geotechnical conditions at Rothera if there is a significant change in the Hangar design during the 2024 – 2025 and 2025 – 2026 Seasons.

At the time of writing this IEE, a confirmed scope of the Wharf activities is not yet fully understood and as such this activity has been included with the level of information available however the environmental effects associated with these require further scrutiny. Assumptions and scenarios are presented in the IEE in relation to the East Mooring Point GI.

The outcomes of the East Mooring Point GI will inform the feasibility of undertaking pullout tests as part of the installation of the new mooring points in the future. The following detail will be incorporated into a suitable EIA but is provided for context. Before permanently installing the mooring point, suitability tests are required to be conducted to inform the strength and capability of the rock to function as a mooring point for the SDA. The creation of a new access road is required in order to perform these tests.

A rock drill would be used to install several anchor points to the mooring point to conduct the ‘pullout test’. If successful, anchors would be transported to the site and grouted to the rock to secure in place. The line that attaches the East Mooring Point to the SDA would be attached by a crane from the Wharf up to the mooring point. During construction, the Optical Hut will have to be temporarily moved away from the site due to its proximity to the proposed access road routes. The proposed access road areas would be cleared of snow and flattened before the access road is excavated.

For all three routes, any services present nearby would be relocated to prevent risk of damage from construction vehicles. At present there are three route options being considered:

- Route A (worst-case option): crosses a steep rocky slope to access the Wharf, and would require rock blasting to create the access route, via previously undisturbed areas at Rothera;
- Route B: slightly easier option, though still crosses rocky terrain with minor incline, requiring hydraulic breaker to break approximately 40 tonnes of rock which would be re-used to profile the access road; and
- Route C: initially follows same alignment as Route B but diverts to track mostly over snow / ice and would require less hydraulic breaker input, therefore resulting in less environmental impact. Additional safety measures would be required to mitigate the risk of excavator sliding down the icy slopes.

All access routes options would require a Specialist Activity Section 6 Permit.

In addition, it is understood that a vessel has not yet been secured to facilitate the removal of historic Biscoe Wharf waste and RMP waste from Rothera to the UK, therefore this activity may not take place as intended and assessed. Should this be postponed then future EIAs will cover this activity cumulatively. In any case the effects are considered to have been assessed within this IEE, with appropriate mitigation measures recommended.

14.2 Future Phases of AIMP

The funding and full scope of future phases has not yet been confirmed and will be considered in future EIA. The works assessed as part of the IEE form part of Phase 2 of the works, in addition at the current stage of planning, remaining Phase 2 activities are anticipated to include:

- Upgrades to contractor facilities (office and accommodation);
- Construction of a new aircraft Hangar;
- Runway upgrades in the form of an extension;
- Construction of a new marine facility;
- New building to replace Giants House;
- Improved access route to East Beach; and
- Proof of concept for renewable energy.

Any future phases of the AIMP are not yet scoped in detail and are yet to be funded.

15. CONCLUSIONS

The scope of works included in this IEE forms an important part of the overall AIMP ambition for BAS to be able to modernise and restore the Rothera infrastructure so that it remains cost effective and sustainable.

Due to the largely temporary nature of the proposed works and minimal constructed elements which will be located in already developed and occupied areas with a low environmental sensitivity, the additional footprint of the works is considered minimal. This is in addition to the fact that many of the works have been assessed within previous IEEs / PEAs and scopes remain unchanged or slightly altered. Associated impacts are considered to be manageable through existing BAS and BAM procedures and with the addition of specific mitigation and monitoring as outlined in Section 13. A full assessment of the potential environmental impacts has been provided within this IEE.

The most significant potential impacts predicted for all four of the activity categories are:

- Introduction of non-native species;
- Cumulative noise impacts due to overlapping construction periods with the Discovery Building;
- Dust deposition on the ice ramp and impacts to local flora and fauna;
- Physical presence, use of space and disturbance to science activities and day-to-day operations;
- Physical and / or mechanical disturbance to land as a result of intrusive SI works; and
- Terrestrial (and potentially marine) pollution from fuel spills.

Having prepared this IEE along with rigorous and specific mitigation measures to reduce the risk of the potential impacts occurring, it is considered that the proposed works will have no more than a minor or transitory impact.

AUTHORS

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Appendix 1
WASTE MANAGEMENT PLANS

Appendix 2
ROTHERA OIL SPILL CONTINGENCY PLAN (OSCP)

Appendix 3
BIOSECURITY PLANS

Appendix 4
WILDLIFE INTERACTION MANUAL

Appendix 5
PREVIOUSLY APPROVED PEAs