

Rothera Site Investigation

Initial Environmental Evaluation



BAS Environment Office
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**British
Antarctic Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

Rothera Site Investigation Initial Environmental Evaluation

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1 INTRODUCTION

1.1 Background to Project

The Natural Environment Research Council (NERC) have commissioned the construction of a new polar research vessel the RRS Sir David Attenborough (SDA), to replace the two existing British polar ships, the RRS Ernest Shackleton and the RRS James Clark Ross. Operated by the British Antarctic Survey (BAS), it is anticipated that the SDA will be ready for use in the 2019/20 season.

The SDA is a much larger research vessel than the current ships and this will have an impact on the requirements for marine infrastructure and cargo storage at all the BAS research stations in Antarctica and South Georgia.

At Rothera Research Station the SDA will require a greater depth of water at the quay side for safe operations than is currently available. The mooring and berthing forces on the existing wharf from the SDA will also be much higher, than the existing ships and therefore the structural elements of the wharf will need to be more substantial. This means that the wharf has to be both upgraded and extended, not just in the east and west directions, but also south into deeper water. Prior to any construction works taking place a site investigation will need to be conducted to evaluate the ground conditions. This will be in the form of rock core sampling and undertaken by a specialist site investigation subcontractor.

BAS have contracted BAM to be the Construction Partner and undertake this site investigation work at Rothera. Due to time constraints BAM have subcontracted this project to Fugro, an international drilling company who will supply the equipment from Chile. Fugro's subcontractors GISA will supply the operators. Further details on Fugro and GISA can be found in Annex 1 - Work Method Statement: Soil Investigation.

1.2 Statutory Requirements

To ensure the protection of the Antarctic environment, the Antarctic Treaty nations adopted the Protocol on Environmental Protection to the Antarctic Treaty in 1991 (hereafter referred to as the Environmental Protocol). The UK enforces the provisions of the Protocol through the 'Antarctic Act 1994 and Antarctic Act 2013' and 'Antarctic Regulations 1995/490 (as amended).

Annex I – Environmental Impact Assessment (EIA)

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

Annex I of the Environmental Protocol sets out the detailed regulations for EIA in Antarctica, and establishes a three-stage procedure based on different levels of impact. The levels are:

- Preliminary Assessment;
- Initial Environmental Evaluation (IEE); and
- Comprehensive Environmental Evaluation (CEE).

An IEE is for activities, which are likely to have a minor or transitory impact on the Antarctic environment. It is considered that an IEE is appropriate for the Rothera Site Investigation works. In the UK the IEE is subject to review by the Foreign and Commonwealth Office (FCO), which also makes

the final decision on whether the activity should proceed.

Permits

The Environmental Protocol also states that certain activities within Antarctica require a Specialist Activity Permit before being undertaken. The activity relevant to the Rothera Site Investigation is "*mineral resource activities for scientific research*". The relevant permit application for this activity will be submitted to the FCO with this IEE.

1.3 Purpose and Scope of Document

The purpose of this IEE is to provide sufficient information on the Rothera Site Investigation for an informed judgement by the FCO to be made on the possible environmental impact of this activity on the Antarctic Environment and whether it should proceed.

The document has been split into the following sections;

- Section 2 provides a description of the projects;
- Section 3 provides a description of the current environment;
- Section 4 outlines the alternatives considered;
- Section 5 identifies the potential environmental impacts and mitigation measures;
- Section 6 provides the conclusions of the IEE.

2 PROJECT DESCRIPTION

2.1 Description of Project

2.1.1 Overview

The Rothera Site Investigation will involve the mobilisation of two drilling rigs which will be sent from Chile to Rothera where they will be assembled and tested. It is anticipated that 3000 litres of Marine Gas Oil will be used to fuel the rigs and this will be sourced from the BAS fuel stocks already stored at Rothera.

It is proposed that 2 sets of 4 boreholes will be drilled. The first set will be on land adjacent to the current wharf area at the southern end of Rothera Point. This is the area marked in green on Fig 1. Waypoint 68°07'39", 67°34'17" to 68°07'43, 67°34'19". This area is currently under consideration for a quarry which is required to extract fill for the wharf extension. Each borehole will be 122.3 mm in diameter from which an 83 mm core will be extracted. Each borehole will be drilled to a maximum depth of 25 metres. The second set of boreholes will be drilled underwater in the area in front of the current wharf. In order to do this the drilling rig will be mounted on a cantilever platform which will be installed on the existing quay. This is the area marked in red on Fig 1. waypoint 68°07'50", 67°34'19" to 68°07'46, 67°34'20". This is the proposed line of the sheet pile wall which will form the face of the redeveloped wharf. Each of these cores will be 83mm in diameter drilled up to a depth of 15 metres.

The exact location of the boreholes within the proposed areas shown on Fig 1 will be confirmed by the design engineer once the drilling team are on site. The total volume of the combined rock cores extracted from the boreholes will be approximately 0.87m³, with a total weight of approximately 2.6 tonnes.

Figure 1. Location of Boreholes



2.1.2 Drilling & Sampling Methods

Drilling and sampling operations will be conducted in accordance with ASTM and ICE UK Specifications for Ground Investigation. These are geotechnical engineering standards which provide best practice guidelines for executing good quality and safe site investigations in order to minimise the risks of unforeseen hazards related to the construction of civil engineering structures.

The proposed drilling rig is the Boart Longyear LX™6 (DB525) which is a multipurpose geotechnical rig capable of wireline and conventional coring, as well as rotary and auger drilling methods. The drilling of each borehole will commence with setting the drill casing into the ground. The the drill pipe will be lowered through the casing down to the ground. It will not be necessary to use drilling fluids (including drilling muds) during the works, due to the firm geological conditions on site. However sea water will be used as an alternative to remove any drill cuttings from the borehole, stabilise the annulus and cool down the drill bit. It is anticipated that 5000 litres of seawater per borehole will be required. This is based on the assumption that the rock is highly fractured. If the rock is more consolidated the quantity of water used will be less. The used seawater will be discharged directly into the ground. Once the borehole is complete the drill casing will be removed.

Rock coring will be conducted using PQ3 diameter drill bits, applying a wireline double-barrel coring system. This will result in a continuous core of rock being obtained. The core run interval will typically be 1.5 m. The cores will be photographed with a scale and colour chart and field tests will be recorded including material type, weathering, hardness etc. The cores will be placed in labelled boxes with date, project number, location, boring number, core number and depth interval. A representative portions of each sample will sealed in airtight bags for laboratory testing.

It is intended to recover all casings and drilling equipment at the end of the works. If casings, drill bits or any other equipment cannot be retrieved and are abandoned during the SI works, full details will be reported to the BAS Environment Office at the time of occurrence. Accurate logs of all drilling activities and recovered materials will be maintained on site.

The main waste material produced by the drilling operation are the drilling arisings. The drill arisings are anticipated to total 0.23 m³, 0.1m³ will be created under water and 0.13m³ on land. These arisings are formed from inert rock and remain uncontaminated by the drilling process. These will not be recovered.

Other waste that will be generated during the works are associated with the general maintenance of the equipment such as grease gun cartridges and oil cans. This waste will be segregated by the drilling team and incorporated into the Rothera waste management system.

2.1.3 Acoustic and Optical Borehole Televierer Logging

The acoustic borehole televierer logger is a high frequency logging device that can provide a 360° ultrasonic picture of the borehole wall. The images produced will be used to measure the orientation and distribution of fractures and areas of stress in the walls of each borehole.

The acoustic borehole televierer probes utilise a piezoelectric transducer that strobes the borehole wall with bursts of ultrasonic energy. Typically the frequency of the ultrasonic beam is in the region of 1.5 megahertz. The received signal is the energy reflected from the borehole wall which has an intensity that is a function of the physical properties of the borehole wall. The intensity signal is high for smooth surfaces in hard rocks and low for irregular surfaces where fracturing may be present. The ultrasound signal attenuates greatly with distance from the source and is beyond the hearing limits of aquatic mammals.

Further details of how the images and data will be presented are included in Annex 1 Work Method Statement Appendix 1 Section 6.3 Page 11. It is intended to create an acoustic televiewer log for each of the 8 boreholes.

[2.1.4](#) Lighting Rig

It is proposed that a lighting rig will be taken to site as a contingency for working in poor light conditions but will not be used at night. The rig is a Magnum Power MLT4060K and operates on marine gas oil with a fuel tank capacity of 114 litres. It can be extended to a height of approximately 9 metres.

[2.1.5](#) Analysis of Samples

The samples will be sent for analysis in Chile at the Fugro laboratory. The full address of the laboratory is:

Av. Americo,
Vespucio 2758-D,
Conchali, Santiago.

In case of availability issues the following backup laboratory will be used:

Lacoos,
Av. Grecia 1408,
Nunoa, Santiago.

Prior to issuing the samples to the laboratory a confidentiality agreement will be signed to confirm the sampling results will only be provided to BAM and BAS for the purposes of the Rothera Wharf redevelopment project. The agreement will include a clause confirming that no additional testing outside the agreed scope will be undertaken. Once the tests have been completed the samples will be sent to a licensed landfill site and waste transfer notes or the equivalent certificates will be issued and sent to BAS. If requested by BAS, samples will be returned to BAS Cambridge directly.

The following tests are anticipated to be carried out on the samples; grain size analysis, Atterberg limits, moisture content, unified soil classification system (USCS) classification, point load strength test, pH, carbonate content, sulphate content and aggregate frost heave. Further details on the methodology for each test can be found in Annex 1 Work Method Statement Section 4.4.4.

[2.1.6](#) Geotechnical Report

A Geotechnical Report will be produced within two weeks of the completion of the lab testing programme and submitted to the BAS Project Manager.

2.2 Programme Schedule, Duration & Intensity of Activity

The site investigation works are due to commence at the beginning of March 2017 and are expected to take no longer than 25 days. It is anticipated that all personnel involved in the site investigation will depart Rothera by the 14th April 2017.

It is anticipated that two of the site investigation team will accompany the drilling rigs whilst being transported on the ship Oscar Viel Toro, operated by the Chilean Navy. It is planned that the ship will leave Chile on 26th February and is due to arrive at Rothera on 2nd March. The rest of the team are anticipated to arrive by the 6th March.

Activity	Duration & Intensity	Dates
Site Investigation	<ul style="list-style-type: none">• 2x drilling operators (GISA)• 2x helper/ drilling assistants incl. 1x welder (GISA)• 1x mechanic (GISA)• 1x televiewer operator (GISA)• 1x geotechnical specialist (GISA)• 1x Supervisor/HSE Manager (BAM) <p>There will be a total of 8 people involved in the site Investigation, who will undertake the work in a total of 25 days over the period 6th March - 14th April 2017.</p> <p>Working hours on site have been agreed as: 0830-1800 Monday - Friday 0830-1400 Saturday</p>	Arrive Rothera 6 th March 2017 Depart Rothera 14 th April 2017

2.3 Personnel

The BAM Project Manager Gerard Turk is the direct point of contact between BAS and BAM and is the overall manager responsible for Health, Safety Environment and Security (HSES), Site Activities, staff, administration, QA and control.

The BAM Superintendent for the project is Danny Brennan who will be responsible for the completion of the site investigation works both on and offshore and will be onsite throughout the proposed activity. The Superintendent will liaise on a daily basis with the Station Leader to coordinate the works with other station activities and be in control of the work force and subcontractors. He will ensure that the appropriate tool box talks are undertaken and will prepare a daily report on the works completed on site. The Superintendent will act as the HSES Manager during the works and will assist the construction team on the relevant health safety and environmental requirements.

The drilling team will be provided by GISA. Six of whom are Chilean nationals and one is a Panamanian national.

3 BASELINE CONDITIONS

A baseline report for the current environmental conditions at Rothera Point has been included in Annex 2 - Environmental Baseline Information for Rother Point, Adelaide Island, Antarctica.

4 ALTERNATIVES

4.1 Do nothing

The proposed Rothera Site Investigation is the preliminary work required for the redevelopment of the Rothera Wharf which will be subject to a separate Environmental Impact Assessment. The extension of the Rothera Wharf is essential for the new polar research vessel the SDA, to be able to moor alongside.

This 'do nothing' alternative has been considered and rejected on the grounds that there are significant benefits gained from carrying out these works. These benefits include informing the Construction Partner of the existing ground conditions which will assist in identifying the most appropriate construction methods for the Rothera Wharf extension. In addition the completion of the site investigation this season could help to avoid unnecessary works in the future which may have a negative environmental impact.

4.2 Do the activity elsewhere

The purpose of the Rothera Site Investigation is to provide data on the ground conditions in the area directly in front of the current wharf where it will be proposed that the new extension will be constructed. The specific location of the boreholes will be determined by engineers once they are on site. In addition boreholes will be taken from an area which is being considered for a quarry to provide the rock fill for the extension. The options for the final quarry location and the final design for the wharf will be presented in a separate Environmental Impact Assessment prior to commencement of the main construction works.

Conducting the proposed Site Investigation works elsewhere would not provide the relevant information required and as such has been rejected as an option.

4.3 Do the activity with alternative equipment or drilling techniques

The drilling rig proposed to be used is the Boart Longyear LX™6 (DB525) which is a multipurpose geotechnical rig capable of wireline and conventional coring, as well as rotary and auger drilling methods. It is particularly suitable for use at Rothera because it has a powerful drill head with high torque and the speed necessary for drilling into hard rock. It is also designed for higher depth capacity which is necessary for the cores required at Rothera.

There are some minor environmental impacts associated with using this drilling rig (outlined in Section 5), however alternative rigs would also result in similar impacts and would not mitigate the anticipated effects. Using a different drilling method such as cable percussive drilling would result in greater noise and disturbance and would not allow the required samples to be collected. There would be no benefit to using alternative equipment or an alternative drilling method.

5 IMPACT IDENTIFICATION & MITIGATION

Environmental impacts associated with the Rothera Site Investigation have been identified in this chapter. Mitigation measures to minimise or avoid these impacts have been suggested beneath each impact.

Table 1. provides a summary of those impacts and provides a qualitative measure of the probability of the impact occurring and the severity of the impact if it were to occur.

All personnel will receive an environmental briefing from the Station Leader on arrival at Rothera which will outline waste management procedures on site, energy and water usage, wildlife watching procedures and biosecurity.

5.1 Importation of Cargo

Potential Impact: Through the unintentional importation of non-native species carried on equipment and general cargo, the local ecosystems (particularly in ice free areas) at Rothera and within Antarctica could be impacted if the non-native species become established. If the impact were realised the severity could be significant on the local ecosystem and on future science.

Mitigation: All equipment and materials required for the proposed activity will be thoroughly cleaned before dispatch to Antarctica.

This includes all the following items of equipment:

- 2 x Borehole drilling rig including pumps and associated items.
- 2 x Cantilever platform.
- All extra lengths of casing (up to 50m).
- All core transport boxes.
- All sampling containers.
- All recording equipment including cameras and tele viewer.
- All consumables including spare parts.
- All small hand tools.

The BAM equipment inspector Billy Sprengel who is a Plant Maintenance Manager, will inspect all plant, equipment, materials and personal belongings prior to loading onto the vessel in Chile and on disembarkation at Rothera. This will include the following checks:

- All re-usable containers are thoroughly cleaned and lined with plastic sheeting.
- No polystyrene or organic packaging material including hay straw or wood shavings is used.
- All wood packaging is new and complies with ISPM 15.
- No corrugated cardboard packaging material used.
- Openings in structural members are to be sealed.
- Containers to be cleaned and fumigated

If soil, seeds or propagules are accidentally imported they must be carefully collected and removed. Rodents must be exterminated immediately. Disposal may include incineration at Rothera or removal from Antarctica. The Rothera Station Leader should be informed immediately.

5.2 Relocation of Personnel and associated luggage/cargo

Potential Impact: Biosecurity breaches as described above.

Mitigation: All personnel being deployed to Rothera will have read and must comply with the BAS Biosecurity Handbook before departing their home country. All personal items of clothing and cargo should be thoroughly cleaned and checked for soils, plants, pollen, propagules or insects.

5.3 Refuelling and use of machinery over ice free ground or water

Potential Impact: Minor spills and fuel leaks could occur during refuelling of the drilling rigs and contaminate the local area. A range of activities from a minor fuel leak from hoses through to or catastrophic failure of the fuel tank could result in contamination of the terrestrial or marine environment.

Mitigation:

- All refuelling will be carried out by trained BAS personnel in line with the station's refuelling procedures. This has been coordinated and confirmed with Rothera Station Management. Drip trays will be used every time the rigs are refuelled and spill kits will be on hand.
- All drilling rig operatives will be briefed on the Emergency Spill Contingency Plan by the Works Supervisor prior to works commencing.
- All plant will be maintained and inspected daily paying particular attention to possible leaks and the condition of hydraulic hoses. These checks will be recorded in the daily Activity Plan compliance record.
- Equipment to be used only requires relatively small quantities of fuel. Each drilling rig has a maximum fuel capacity of 60 litres, and hydraulic oil capacity of 200 litres
- All BAM, Fugro and GISA staff will have received training on emergency spill procedures.
- The Emergency Spill Contingency Plan and the required spill kit components are contained in Annex 1 of this IEE - *Works Method Statement Appendix B*.
- All spills will be reported to the Station Leader at the time of occurrence.
- Location proposed for on shore drilling is not ecologically sensitive and does not support any known flora or fauna.
- Tier 1 spills will be dealt with by BAM staff.
- Tier 2 or 3 spills will be coordinated by Rothera Station Leader
- Any spills over water will be considered as Tier 2 spills and will be reported to the Rothera Station Leader immediately.
- BAM, Fugro and GISA staff will assist with any spill response under the co-ordination of the Rothera Station Leader.
- *Rothera Oil Spill Contingency Plan 5th edition 2015* to be followed in the event of a spill over water.
- Spill kits to be kept in close proximity to drilling rigs at all times.
- All spills to be reported to the BAS Environment Office .

5.4 Underwater drilling - noise

Potential Impact: Noise impacts which cause disturbance or injury to marine mammals

Noise measurements of a similar drilling rig¹ drilling hard rock have been carried out by BAM. The results showed that at a distance less than 1 metre from the rig, an average sound pressure level (SPL) of 86.6 dB(A) re. 20 µPa and a peak Sound Pressure Level(SPL)² of 104.2 dB(A) re. 20 µPa at source. This measurement includes both the noise of the diesel engine and the drilling head in air. Underwater these measurements equate to an average SPL of 148.1 dB(A) re. 1 µPa and a peak SPL of 165.7 dB(A) re. 1 µPa at source. This figure includes for the noise of the diesel engine even though the noise of this will be negligible under water.

The results showed an average sound pressure level (SPL) of 86.6 dB(A) re. 20 µPa and a peak SPL of 104.2 dB(A) re. 20 µPa at source. This measurement includes both the noise of the diesel engine and the drilling head in air. Underwater these measurements equate to an average SPL of 148.1 dB(A) re. 1 µPa and a peak SPL of 165.7 dB(A) re. 1 µPa at source.

For aquatic mammals³, a level of 224 dB peak SPL has been suggested causes behavioural change and a level of 230 dB peak SPL has been suggested causes injury⁴ (Southall et al. 2007).

These levels are based on pulses of noise not the constant noise of the drilling operations but are thought to be appropriate as the mammals have the ability to swim away if the noise is disturbing. Based on the assumptions made it is unlikely that the rig would cause significant disturbance to marine mammals.

¹Noise measurements were taken of a Boart Longyear LX™4 (DB520). The rig to be used at Rothera is a LX™6 (DB525) which has an upgraded mast for higher depth capacity. Both machines use the same 53kW Deutz D914 Air Cooled Diesel Engine.

²Sound Pressure Level (SPL) is measured in decibels (dB). This is not an absolute unit of measure but a measure of sound intensity relative to a fixed reference intensity. In air the SPL is calculated using 20 micro Pascal (µPa) as the reference intensity, whilst in water the reference intensity used is 1 µPa.

³The report considers the effects of noise on cetaceous species and pinnipeds. The cetaceans are divided into those with low frequency, mid frequency and high frequency auditory bandwidths.

⁴Behavioural change is defined as the sound level at which temporary threshold shift occurs, which is a temporary loss of hearing after exposure to sound. Injury is the sound level at which an auditory injury occurs.

Reference: Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene Jr., C. R., Kastak, David, Ketten, D. R., Miller, J. H., Nachtigall, P. E., Richardson, W. J., Thomas, J. A., and Tyack, P. L. (2007). *Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations*. Aquatic mammals, 33(4), 411-509.

Mitigation:

- No percussive drilling will occur underwater only rotary coring.
- By carrying out this ground investigation work, the noise emitted during the permanent works construction next season will be reduced as pile embedments will be based on known parameters rather than worse case scenarios. This could reduce the duration of the piling works during wharf construction.

- Marine mammal and penguin observations will take place prior to the commencement of underwater drilling activities. Members of the Rothera Dive Team routinely undertake observations for leopard seals and orcas in the waters around the wharf and will be consulted on how to undertake marine mammal and penguin observations. The procedure below will be followed:
 - Ten minutes before the commencement of underwater drilling activity, one or more observers must look for the presence of penguins and marine mammals (whales and seals) in the sea in the vicinity of the wharf. Drilling must not commence if penguins and/or marine mammals are observed within 100 metres of the wharf.
 - If, at the end of the 10 minute observation period, (1) a penguin or marine mammal is observed within 100 metres of the wharf, or (2) a penguin or marine mammal is observed swimming towards the wharf and about to move into an area within 100 metre of the wharf, the commencement of drilling will be delayed until the penguin or marine mammal has left the area.
 - Drilling may commence if penguins and/or marine mammals are observed on land within 100 metres of the wharf.
 - Marine mammals may swim to within 100 m of the wharf after drilling has commenced. Under this circumstance, drilling may continue.

5.5 Underwater drilling - sediment plumes

Potential Impact: Sediment plumes created during drilling activities which could impact marine benthic communities and the drinking water intake

Based on the following calculation BAM predict that the drilling of each near shore hole will produce approximately 0.1 m³ of fine sediment.

The drill radius is 61.1 mm and the core radius is 41.5 mm. Therefore the cross sectional area of the rock to be drilled is $(\pi \times 0.0611^2) - (\pi \times 0.0415^2) = 0.0063 \text{ m}^2$. Multiplying this by the depth of drilling, 15 m gives the volume 0.0945 m³.

Each hole is likely to take 16 hours to drill therefore the sediment is produced at an approximate rate of 0.00625 m³ hour this equates to approximately 20g/hour. With 2 rigs working on the near shore area 40g of sediment will be produced each hour. Due to the rock density (3000kg/m³), it is considered unlikely that any sediment created during the drilling activity will remain suspended for a prolonged period.

Mitigation:

- Visual monitoring of any sediment plumes will be undertaken during underwater drilling. Liaison with the Rothera Facilities Manager must occur to ensure that the drinking water intake pipe can be closed if there is a risk of contamination.
- Pre and post drilling underwater surveys will be conducted by BAS to monitor the impact of this activity.

5.6 Generation of waste

Potential Impact: Inappropriate disposal of waste materials

Mitigation:

- All personnel will receive an environmental briefing from the Station Leader on arrival at Rothera which will outline waste management systems on site.

- All waste must be segregated and incorporated into the existing waste management procedures at Rothera.
- Drill cuttings and sea water used in the drilling operations will remain uncontaminated and will be discharged directly on site.
- The rock cores will be disposed of in landfill in Chile once all sample testing has been completed. Waste transfer notes or equivalent certification will be provided to BAS as confirmation.
- Daily checks of the site by the Superintendent will ensure that all equipment and packaging is appropriately weighed down to avoid wind blow.

5.7 Use of Lighting Rig

Potential Impact: Birds may be attracted to unnatural lighting source which would result in injury or fatalities.

Mitigation:

- Lighting rigs only to be used in low light during the period of 0830 - 1800 hours and not in total darkness.
- Drill team will remain vigilant at all times and note the presence of birds
- Lights will be turned off if a bird strike occurs
- Station Leader to be informed immediately of any bird strikes and procedure to be reviewed
- Environment Office to be informed in bird strike occurs

5.8 Cumulative Impacts

A cumulative impact is the combined impact of past, present and future activities over time or space. The proposed Rothera Site Investigation works is the first stage in the larger project to upgrade and extend Rothera Wharf. The full impact of the overall project will be considered in an Environmental Impact Assessment which will be submitted to the FCO prior to construction activities.

Table 1. Probability and Severity of Impacts

Activity	Effect	Possible Impact	Probability of impact occurring	Severity of impact	Preventative or mitigating measures
Rothera Site Investigation					
1. Importation of cargo	<ul style="list-style-type: none"> Possible importation of non-native species 	<ul style="list-style-type: none"> Potential ecosystem alteration. Impact on future science. 	Low	Medium (High if species become established)	<ul style="list-style-type: none"> All equipment and materials will be thoroughly cleaned before dispatch to Antarctica. BAM will inspect all plant, equipment, materials and personal belongings prior to loading onto the vessel in Chile and prior to disembarkation at Rothera. If accidental importation of a non-native species occurs it will be exterminated, and disposed of appropriately. All non-native species incursions will be reported to the Rothera Station Leader immediately and the BAS Environment office.
2. Relocation of personnel and associated luggage/cargo	<ul style="list-style-type: none"> Possible importation of non-native species 	<ul style="list-style-type: none"> Potential ecosystem alteration. Impact on future science. 	Low	Medium (High if species become established)	<ul style="list-style-type: none"> All personnel being deployed to Rothera will have read and must comply with the BAS Biosecurity Handbook before departing their home country. All personal items of clothing and cargo should be thoroughly cleaned and checked for soils, plants, pollen, propagules or insects.
3. Refuelling and use of machinery over ice free ground and water	<ul style="list-style-type: none"> Fuel spills and leaks 	<ul style="list-style-type: none"> Contamination of local environment (terrestrial and marine) 	Low	Low	<ul style="list-style-type: none"> All refuelling will be carried out by trained BAS personnel in line with the station's refuelling procedures. Spill kits to be kept in close proximity to drilling rigs at all times. Equipment to be used requires relatively small quantities of fuel. All BAM, Fugro and GISA staff will have received training on emergency spill procedures. All rig operatives to be briefed on Emergency Spill Contingency Plan All spills will be reported to the Station Leader Location proposed for on shore drilling is not ecologically sensitive and does not support any known flora or fauna Tier 1 spills will be dealt with by BAM staff, tier 2 or 3 spills will be coordinated by Rothera Station Leader Any spills over water will be considered as Tier 2 spills and will be reported to the Rothera Station Leader immediately. BAM, Fugro and GISA staff will assist with any spill response under the co-ordination of the Rothera Station Leader. Rothera Oil Spill Contingency Plan 5th edition 2015 to be followed in the event of a spill over water.

					<ul style="list-style-type: none"> All spills will be reported to the BAS Environment Office.
4. Underwater drilling - noise	<ul style="list-style-type: none"> Change in underwater noise levels 	<ul style="list-style-type: none"> Disturbance or injury to marine mammals 	Low	Medium	<ul style="list-style-type: none"> No percussive drilling will be conducted underwater. Only rotary coring will be used. Calculations undertaken indicate noise levels will be low and will not be significant to marine mammals. By carrying out this ground investigation work, the noise emitted during the main construction works next season could be reduced. Marine mammal and penguin observations will take place prior to the commencement of underwater drilling activities.
5. Underwater drilling – sediment plume	<ul style="list-style-type: none"> Change in underwater sediment levels 	<ul style="list-style-type: none"> Disturbance or injury to marine benthic community 	Low	Low	<ul style="list-style-type: none"> Pre and post drilling underwater surveys will be conducted by BAS to monitor the impact of this activity. Calculations undertaken indicate suspended sediment levels will be low.
6. Generation of Waste	<ul style="list-style-type: none"> Inappropriate disposal of waste 	<ul style="list-style-type: none"> Contamination of site 	Low	Low	<ul style="list-style-type: none"> All personnel must adhere to waste management procedures on site. All waste must be segregated and incorporated into the existing waste management systems at Rothera. Drill cuttings and sea water used in the drilling operations will remain uncontaminated and will be discharged directly on site. The rock cores will be disposed of in landfill in Chile Daily checks will ensure that all equipment and packaging is appropriately weighed down to avoid wind blow
7. Use of Lighting Rig	<ul style="list-style-type: none"> Creation of artificial light which may attract birds 	<ul style="list-style-type: none"> Bird Strikes resulting in bird injury or fatality 	Low	Medium	<ul style="list-style-type: none"> Lighting rigs only to be used in low light not total darkness Drill team to remain vigilant at all times and note the presence of birds Lights to be turned off if a bird strike occurs Station Leader to be informed immediately of any bird strikes and procedure to be reviewed Environment Office to be informed in bird strike occurs

6 CONCLUSIONS

This IEE indicates that the proposed Rothera Site Investigation is likely to have no more than a minor and transitory impact on the Antarctic environment, provided the recommended mitigation measures identified in this report are carried out. It is therefore concluded that this activity should be allowed to proceed, and that a Comprehensive Environmental Evaluation (CEE) is not required.

7 AUTHORS OF THE IEE

This Initial Environmental Evaluation was prepared by Clare Fothergill, British Antarctic Survey with input from BAM Environmental Manager Neil Goulding.

Annex 1 The Works Method Statement was produced by BAM and Fugro

Annex 2 Environmental Baseline Information for Rothera Point was produced by Kevin Hughes

Further information or copies of this IEE can be obtained from:

BAS Environmental Office
British Antarctic Survey
High Cross, Madingley Rd
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United Kingdom

8 Annex 1 - Works Method Statement: Soil Investigation BAM

9 Annex 2 - Environmental Baseline Information for Rothera Point