Brynhild Field Decommissioning Project: Draft Environmental Appraisal

Prepared for: **Lundin Norway AS**
Lundin Document No.: **21488-TEFMC-000-Y-RA-00005**
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Genesis Document No.: J74927A-Y-RT-24003/D3
Date: January, 2020

Rev. No.		Date	Description	Issued by	Checked by	Approved by	Client Approval
Orig.	Client						
A1	-	19/06/19	Issued for internal review	MOS	LDi		
B1	A	21/06/19	Issued for client review	MOS	LDi/SK	AH	
D1	01	08/07/19	First pre-draft for issue to OPRED	MOS	LDi	AH	
D2	02	28/11/19	Second pre-draft for issue to OPRED	MOS	NGr	MOS	
D3	03	15/01/20	Consultation Draft	MOS	NGr	MOS	LH

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STANDARD INFORMATION SHEET

Project Name	Brynhild Decommissioning Environmental Appraisal (EA)
Block and Licence No.	Norwegian Block 7/7. Infrastructure on UKCS is located within Blocks 23/22 and 23/27. Production licence PL148 on the Norwegian Continental Shelf
Type of Project	Decommissioning
Undertaker	Lundin Norway AS
Licensees/Owners	The equity holders comprise: **Co-venturers** / **Equity interest (%)** Lundin Norway AS — 51 CapeOmega AS — 49
Short Description	The Brynhild Field is located on the Norwegian Continental Shelf and was developed as a subsea tie-back to the Haewene Brim Floating Production Storage and Offloading (FPSO) vessel located at the Pierce Field on the United Kingdom Continental Shelf (UKCS). Cessation of production was agreed in Q2 2018 such that Lundin Norway AS are currently preparing to decommission the field. Following agreement with the UK and Norwegian regulators, the Decommissioning Programme (DP) and supporting documents (including this EA), required for UK regulatory approval, will only address the infrastructure located within the UKCS. This document therefore considers the impact of the activities associated with the decommissioning of the Brynhild infrastructure located on the UKCS. A production pipeline, water injection pipeline and an umbilical connect the Brynhild wells to the FPSO. These lines are approximately 37 km in length and approximately 12 km of each line occurs within UK waters. All lines are trench and buried to around 1 m top of pipe. In areas where this depth was not reached, spot rockdump was laid. The production pipeline and umbilical are laid in the same trench. At the approach to the FPSO, rockdump protects the pipelines and umbilical where they exit the trenches. A small number of structures and five mattresses located within the FPSO's 500 m exclusion zone will be recovered as part of the Brynhild DP. Recovery of these structures will result in short lengths of the pipelines and umbilical becoming exposed. Following a comparative assessment, it was determined that the pipelines and umbilical will be decommissioned *in situ* and the ends that become exposed following recovery of the mattresses and structures will be remediated. Base case is to cut and recover these exposed ends.
EA Prepared by	Lundin Norway AS and Genesis

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ACRONYMS

%	Percent
°C	Degrees Celsius
µm	Micrometres
AIS	Automatic Identification Systems
BAOAC	Bonn Agreement Oil Appearance Code
BEIS	Business Energy and Industrial Strategy
CA	Comparative Assessment
CNS	Central North Sea
CoP	Cessation of Production
CSIP	Cetacean Stranding Investigation Programme
Defra	Department for Environmental Food and Rural Affairs
DP	Decommissioning Programme
EA	Environmental Appraisal
EEMS	Environmental Emissions Monitoring System
EMT	Environmental Management Team
EUNIS	European Nature Information Service
ENVID	ENVironmental and socio-economic impact IDentification Workshop
ESAS	European Seabirds at Sea
ESIA	Environmental and Socio-Economic Impact Assessment
ESRA	Environmental and Social-Economic Risk Assessment
FJSS	Flexible Jumper Support Structures
FPSO	Floating Production Storage and Offloading
GIS	Geographic Information System
GRP	Glass Reinforced Plastic
ICES	International Council for the Exploration of the Sea
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of nature
JNCC	Joint Nature Conservation Committee
kg	Kilogram
km	Kilometres
m	Metre
m^2	Square Metres
m^3	Cubic Metres
MARPOL	The International Convention for the Prevention of Pollution from Ships
MCAA	Marine and Coastal Access Act
MCZ	Marine Conservation Zone
mg	Milligram
mg/kg	Milligrams per Kilogram
m/s	Metres per Second
MPA	Marine Protected Area
MPE	Ministry of Petroleum and Energy
MSS	Marine Science Scotland
NCMPA	Nature Conservation Marine Protected Area
NCS	Norwegian Continental Shelf
nm	Nautical Miles
NMP	National Marine Plan
NMPi	National Marine Plan interactive
NORM	Naturally Occurring Radioactive Material
ODU	Offshore Decommissioning Unit
OGA	Oil and Gas Authority

OGUK	Oil and Gas UK
OPEP	Oil Pollution Emergency Plan
OPPC	Oil Pollution Prevention and Control
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSCAR	Oil Spill Contingency and Response
PLET	Pipeline End Termination
PMF	Priority Marine Feature
PNEC	Predicted No Effect Concentration
ppb	Parts per Billion
PVA	Particularly Valuable Area
RBM	Riser Base Manifold
ROV	Remotely Operated Vehicle
ROVSV	Remotely Operating Vehicle Support Vessel
SAC	Special Area of Conservation
SCANS	Small Cetacean Abundance in the North Sea
SFF	Scottish Fishermen's federation
SINTEF	Stiftelsen for Industriell og Teknisk Forskning
SMRU	See Mammal Research Unit
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
spp.	Species
te	Tonne
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
VMS	Vessel Monitoring Systems
WMP	Waste Management Plan

NON-TECHNICAL SUMMARY

The Brynhild Field is a subsea development located in Norwegian Block 7/7. The field was developed as a tie-back to the Haewene Brim Floating, Production, Storage and Offloading (FPSO) vessel, located at the Pierce Field in UK licence Block 23/27a of the Central North Sea (CNS).

Production from the Brynhild Field commenced in 2014 with peak oil production in 2015. Production ceased in 2018, due to the field being no longer economically viable. Field life extension and reuse options have been considered and were all found to be sub-economic such that Cessation of Production was agreed in Q2 2018. Lundin Norway AS (hereafter referred to as Lundin), as the field operator (with a 51 % interest), is therefore preparing to decommission the field on behalf of themselves and their partners, CapeOmega AS.

Lundin has prepared this Environmental Appraisal (EA) in support of the draft Decommissioning Programme (DP) that is being submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED). Following agreement with the UK (OPRED) and Norwegian (Ministry of Petroleum and Energy (MPE)) regulators, the scope of the DP and supporting Comparative Assessment (CA) and EA is limited to the infrastructure located within the UKCS.

Background Information

Four wells were drilled at the Brynhild Field: three production wells and one water injection well, with one of the production wells being converted to a water injection well at a later date. The wells were drilled at a single manifold and are connected to the Haewene Brim FPSO via a production pipeline (PL3083), a water injection pipeline (PL3084) and an umbilical (PLU3085). All lines (i.e. the pipelines and umbilical) are approximately 37 km in length and are trenched and buried with rock placement in some areas. Approximately 12 km of each of the lines are located on the UKCS. The production pipeline and umbilical are laid in the same trench, whilst the water injection pipeline is laid in a separate trench (Figure 1). For the most part, the trenched lines are backfilled and buried to a top of pipe depth of around 1 m. Where this depth of coverage was not reached, rockdump was added. In addition, rockdump was used where the pipelines and umbilical exit the trench at the approach to the Haewene Brim FPSO.

There are a small number of structures within the Haewene Brim's 500 m exclusion zone that are associated with the Brynhild Field. These include a Pipeline End Termination (PLET) and a Riser Base Manifold (RBM). Both these structures have jumper support structures and Glass Reinforced Plastic (GRP) protection covers associated with them.

Within the UKCS there are 36 mattresses associated with the Brynhild infrastructure. Of these 36 mattresses, 31 provide stabilisation under the pipelines and umbilicals and are covered with rockdump. The remaining five exposed mattresses occur within the 500 m zone and provide protection to the water injection pipeline. There are an estimated 432 x 25 kg grout bags associated with the buried mattresses. There are no grout bags associated with the five exposed mattresses.

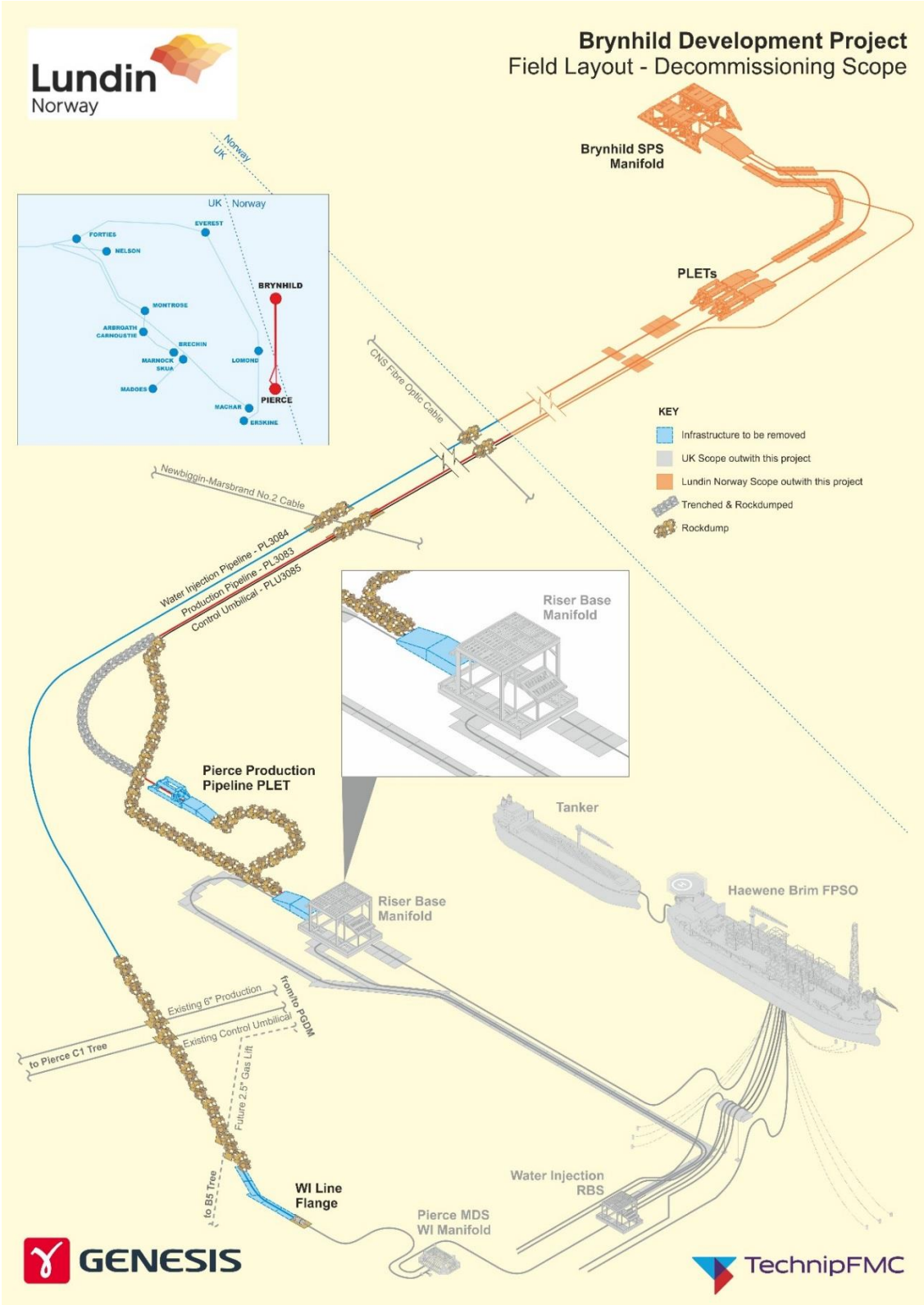


Figure 1: Representative Schematic of the Brynhild Development

Stakeholder Engagement

Consulting with stakeholders is an important part of the environmental impact assessment process as it allows any concerns or issues which stakeholders may have, to be communicated and addressed. As part of the informal stakeholder engagement process a Scoping Report was issued to a number of stakeholders. The Scoping Report provided an overview of the Brynhild Field, the proposed decommissioning activities (as known at the time) and an overview of the impacts to be assessed in this EA. Stakeholders were invited to comment on the Scoping Report with respect to any concerns they may have. In addition to issuing the Scoping Report, Lundin have carried out informal stakeholder engagement sessions with OPREDs Offshore Decommissioning Unit and OPREDs Environmental Management Team. Comments received on the Scoping Report and issues raised during the meetings have been addressed in this report.

Decommissioning Activities

A CA was carried out to determine the best method of decommissioning the 12 km (approximate length) of pipelines and umbilical located on the UKCS. The CA concluded that decommissioning *in situ* and cutting and removing the exposed ends was the most preferable option. However, this option was found to be only marginally better than trenching and burying or rockdumping the exposed ends. The CA therefore proposed that these three partial remediation options could be carried through to the execution tendering stage.

Currently it is anticipated that apart from the Brynhild RBM, all of the Brynhild structures located within the Haewene Brim's 500 m exclusion zone will be recovered. The Brynhild RBM will not be decommissioned as part of the Brynhild DP as the main Pierce production pipeline ties into it. The decommissioning of this structure will be addressed as part of the Pierce DP. Two GRP protection covers located at the Brynhild RBM will be temporarily removed to enable the Brynhild infrastructure beneath to be recovered as part of the decommissioning programme. Following removal of the Brynhild infrastructure the two covers will be reinstated to retain protection to a Pierce tie-in, with the responsibility for the decommissioning of the GRP covers becoming the responsibility of the Pierce operators at the end of field life.

The five exposed mattresses laid within the Haewene Brim's 500 m exclusion zone will be recovered. The buried mattresses and grout bags will be decommissioned *in situ*. Existing rockdump will be decommissioned *in situ*.

Following decommissioning activities, Lundin will provide evidence that the seabed is free of debris and the area is safe for other sea users.

Environmental and Socio-Economic Baseline

The Brynhild Infrastructure located on the UKCS occurs within Blocks 23/22 and 23/27 at a water depth of approximately 86 m.

Within the area, winds can occur from any direction, but the main winds throughout the year are from the south and west. The predominant wind speeds throughout the year are moderate breezes at 6 – 10 m/s, although this is variable, and the strongest winds tend to occur in winter months.

The mean spring tidal range within the region ranges from 0.1 – 1.0 m, and the annual mean significant wave height within the area ranges from 2.11 – 2.40 m (Scottish Government NMPi, 2019).

The seabed sediments across the area are broadly considered to comprise two habitat types: Circalittoral Muddy Sand (EUNIS Code A5.26) and Circalittoral Mixed Sediment (EUNIS Code A5.44).

Plankton, benthic and fish species in the area are typical of the Central North Sea. Cetaceans known to occur in the area include the harbour porpoise, minke whale, white-beaked dolphin and Atlantic white-sided dolphin.

Demersal fishing gear is used in the area, though recent landings data suggest that UK fishing activity in the area can be considered relatively low.

Shipping activity in the area is considered low. There are no telecommunications cables, aggregate extraction areas, military exercise areas or renewable energy developments within the vicinity of the proposed decommissioning activities.

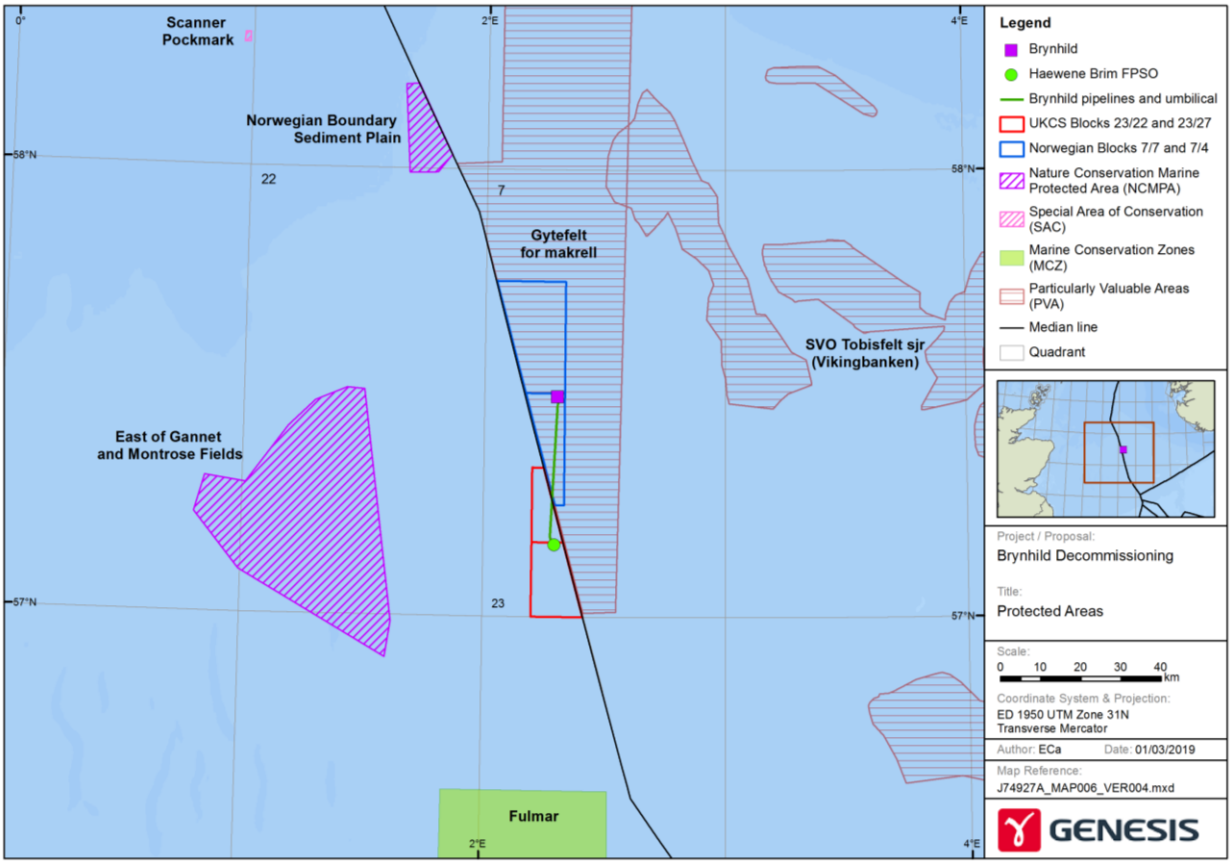


Figure 0-2: Location of the Brynhild Field Development.

Impact Assessment

In order to determine the impact of the proposed decommissioning activities, Lundin held an Environmental Impact Identification Workshop which considered the proposed decommissioning activities and their potential environmental and socio-economic impacts.

Receptors considered in the workshop included: air, water and sediment quality, plankton, benthic species, fish, marine mammals, seabirds, designated areas, coastal communities, fisheries, shipping, landfill resources, resource use, local communities and cultural heritage. The impacts of emissions to air, discharges to sea, seabed disturbance, underwater noise, and waste production on each of these receptors was considered. In addition, the physical presence of the vessels during operations and the items to be decommissioned *in situ* were considered.

For all of the planned activities the environmental and social impacts were considered to be of low significance when standard industry mitigation measures were applied.

The Environmental Impact Identification Workshop identified one accidental event that has the potential to be a of moderate environmental significance: a loss of diesel due to vessel collision. When the impact significance and likelihood were taken into account, the environmental risk was considered to be low.

Environmental Management

The Brynhild Decommissioning Project will be aligned to Lundin's goal to 'minimise the impact to the environment'.

Atmospheric emissions will be managed by inspection of the vessels contracted to carry out the work and by planning vessel schedules to ensure efficient operations. Fuel consumption will be recorded throughout the decommissioning operations.

Lundin will implement a Waste Management Plan. The inventory of decommissioned items will distinguish equipment that can be reused, materials that can be recycled and waste for appropriate disposal. Naturally Occurring Radioactive Material (NORM) is not expected to be present, but if it is detected, the contaminated waste will be sent for appropriate treatment. Waste management activities will be conducted in full compliance with all relevant legislation and regulatory controls. Disposal to landfill will be the waste management option of last resort.

Stringent control measures and operational procedures will be implemented to prevent accidental events involving the release of hydrocarbons or chemicals.

Lundin will provide independent verification of seabed clearance and post-decommissioning survey requirements will be agreed with OPRED.

Table 1 lists procedural and technical controls and mitigation measures identified in the preparation of this EA to reduce impacts to a level that is 'as low as reasonably practicable'.

Table 1: Decommissioning of the Brynhild Field Infrastructure in the UKCS: Project Specific Commitments.

Aspect	Commitment
Physical presence	• Consultation with Scottish Fishermen's Federation (SFF); • Notice to mariners will be circulated; • Vessel use will be optimised • All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972). • If used, rock cover will be optimised and carefully managed. A fall pipe will be used to ensure accuracy of the rock dumping. Size of rock cover will be in accordance with industry practice which is also the preferred SFF / industry best practices.
Atmospheric emissions and energy use	• As part of the tendering process, proposed vessels will go through a detailed assurance process which will include a review of generator and engine maintenance which leads to better efficiency in line with manufacturer's specifications. • Decommissioning vessel schedules will be planned to optimise (minimise) vessel use. • Prior to the contract award, Lundin will audit the decommissioning yards to ensure suitable permits are in place and that atmospheric emissions are being managed.

Aspect	Commitment
	• Activities will be carried out in line with Lundin's environmental policy which includes minimising emissions.
Discharges to sea	• Lundin will carry out a detailed assurance process on all vessels prior to contract award. • Work procedures will be in place to minimise offshore campaigns. • Only MARPOL compliant vessels will be used. • Flushing and cleaning of topsides and pipelines is completed in line with BAT/BEP requirements. • All contracted vessels will be signed up to the International Maritime Organization (IMO) and will adhere to their guidelines. • Any associated discharges will be managed to minimise impact.
Physical disturbance of the seabed and marine species	• Work procedures in place. • Use of rockdump will be minimised. • Priority will be given to the use of non-intrusive survey methods for determining a clear seabed.
Onshore activities	• Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.
Waste Management	• The Brynhild Project will have in place a Waste Management Plan developed to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes. • Waste management options will take account of the waste hierarchy. • As part of Lundin's Duty of Care, contract award will be to an established yard with appropriate experience, capability, licences and consents in place.
Accidental events	• Any infrastructure decommissioned *in situ* will be marked on FishSafe and communicated accordingly. • Work procedures in place. • Use of trained personnel to carry out bunkering operations. • Vessel assurance inspections. • Emergency response plans in place including SOPEPs (shipboard oil pollution emergency plan). • SIMOPS (simultaneous operations) will be managed through bridging documents and communications.

Conclusion

This EA has assessed the impacts and risks associated with the proposed decommissioning activities in the context of the environment within which the Brynhild infrastructure is situated. With implementation of the proposed mitigation measures, the environmental impact of the decommissioning activities is likely to be minimal and temporary with regard to disturbed seabed within the project footprint. Recovery of the ecology is expected to begin immediately on completion of the activities.

To conclude, the proposed decommissioning of the Brynhild infrastructure within the UKCS will leave the area in a condition suitable for re-colonisation by local species and safe for fishermen

1. INTRODUCTION

The Brynhild Field lies in Norwegian Block 7/7 and is operated by Lundin Norway AS (hereafter referred to as Lundin). The field is tied back to the Haewene Brim Floating, Production, Storage and Offloading (FPSO) vessel, located at the Pierce Field in UK licence Block 23/27a of the Central North Sea (CNS) (Figure 1-1).

Lundin has prepared this Environmental Appraisal (EA) under the Petroleum Act 1998, in support of the draft Decommissioning Programme (DP) that is being submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED). The purpose of the draft DP is to seek approval for the decommissioning of the Brynhild infrastructure laid within the United Kingdom Continental Shelf (UKCS) waters.

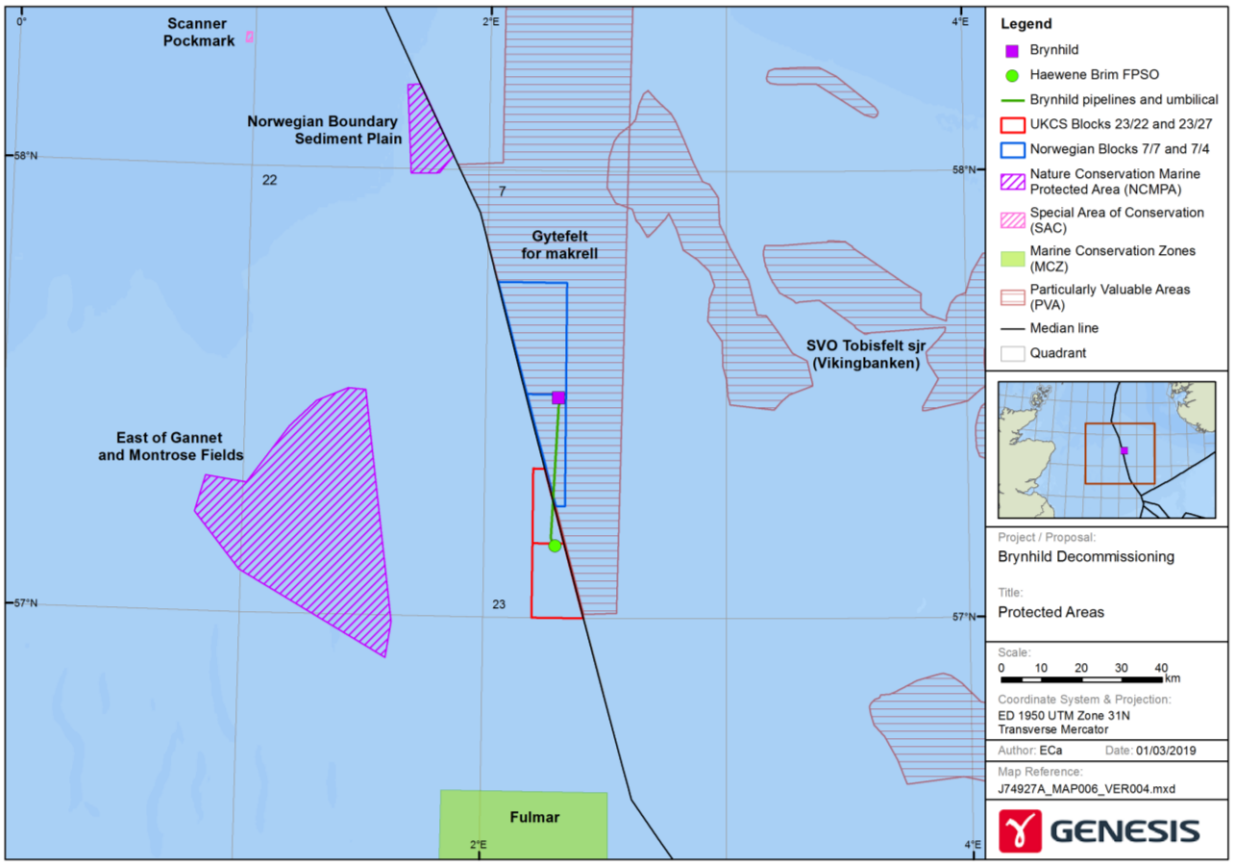


Figure 1-1: Location of the Brynhild Field Development.

1.1 Purpose of the Document

Under the Petroleum Act 1998 there is a requirement to undertake an assessment of the potential environmental impacts of any proposed decommissioning proposals (BEIS, 2018). The EA identifies those activities likely to have an environmental impact. These activities were identified by holding a Scoping ENVironmental Issues IDentification (ENVID) Workshop to discuss the proposed activities and their potential environmental and socio-economic impacts assuming standard industry mitigation measures. The findings of the Workshop have informed the EA with respect to identifying those aspects (e.g. seabed disturbance, waste processing etc.) requiring further assessment.

1.2 Project Background

The Brynhild Field is located within production licence PL148 on the Norwegian Continental Shelf (NCS), approximately 265 km east of Aberdeen and 2.3 km east of the UK/Norwegian median line.

Production from the Brynhild Field commenced in 2014 with peak oil production in 2015. Production ceased in 2018, due to the field being no longer economically viable. Field life extension and reuse options have been considered and were all found to be sub-economic such that Cessation of Production (CoP) was agreed in Q2 2018. Lundin as the field operator (with a 51 % interest), is therefore preparing to decommission the field on behalf of themselves and their partners, CapeOmega AS (who hold the remaining 49 % stake in the field).

Four wells were drilled at the Brynhild Field: three production wells and one water injection well, with one of the production wells being converted to a water injection well at a later date. The wells were drilled at a single manifold and are connected to the Haewene Brim FPSO via a production pipeline (PL3083), a water injection pipeline (PL3084) and an umbilical (PLU3085). All lines (i.e. the pipelines and umbilical) are approximately 37 km in length and are trenched and buried with rock placement in some areas. The production pipeline and umbilical are laid in the same trench, whilst the water injection pipeline is laid in a separate trench (Figure 1-2). For the most part the trenched lines are backfilled and buried to a to a top of pipe depth of around 1 m. Where this depth of coverage was not reached, rockdump was added.

Following agreement with the UK (OPRED) and Norwegian (Ministry of Petroleum and Energy (MPE)) regulators, the DP and supporting Comparative Assessment (CA) and EA will only address the infrastructure located within the UKCS. Approximately 12 km of each of the pipelines and umbilical are laid within the UKCS.

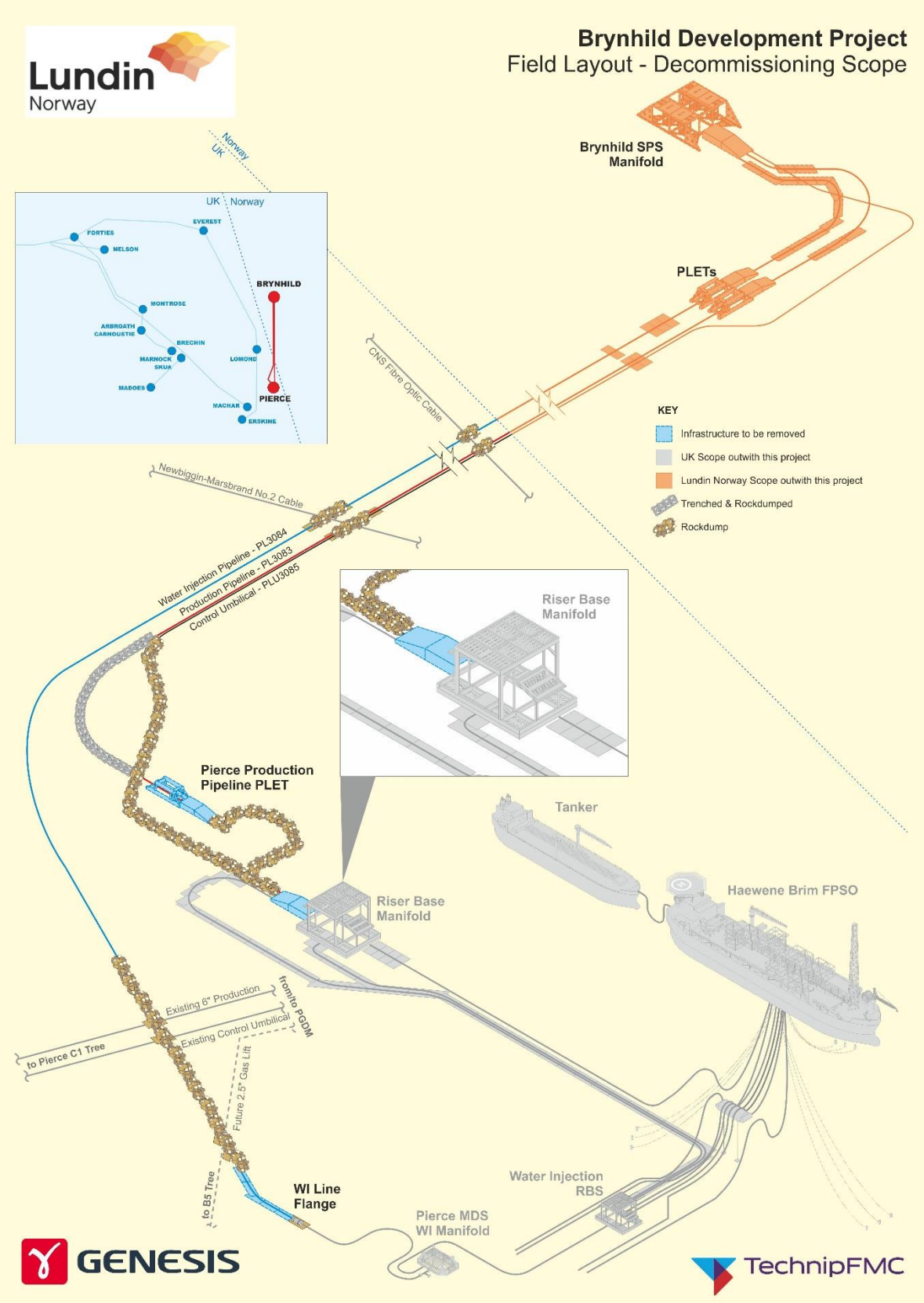


Figure 1-2: Representative Schematic of the Brynhild Development.

1.3 Document Layout

To determine the environmental and socio-economic impacts of the Brynhild DP, an understanding of the regulatory context, stakeholder concerns, the proposed activities and the environmental and socio-economic baseline is required. Table 1-1 details the structure of the EA report.

Table 1-1: Structure of the EA Report.

Chapter No.	Title	Contents
	Non-Technical Summary	A summary of the EA Report.
1	Introduction	Introduction to the project and a summary of applicable legislation.
2	Stakeholder Engagement	Details of the consultation process to date.
3	Project Description	A description of the facilities (pipelines, umbilical, structures and stabilisation features) to be decommissioned, the proposed decommissioning activities and an indicative schedule of activities.
4	Comparative Assessment	Summary of the results of the CA carried out for the pipelines, power cables and mattresses.
5 and 6	Environmental and Socio-Economic Baseline	A description of the environmental (Chapter 5) and socio-economic (Chapter 6) receptors in the area.
7	Scoping of Potential Environmental Impacts	Description of the methodologies used to determine the environmental and socio-economic impact significance of planned activities and the environmental and socio-economic risk of accidental events. An overview of those aspects that are not considered to have a significant impact is also presented in this section.
8	Impact Assessment	Detailed assessment of the impact on seabed disturbance, waste processing and an accidental hydrocarbon release.
9	Conclusions	Key findings of the EA.
Appendix A: Assessment Methodology		Assessment Methodology used during Scoping ENVID Workshop
Appendix B: ENVID Results		ENVID Results

1.4 Regulatory Context

In the UK, decommissioning is regulated by OPRED under the Petroleum Act 1998 as amended by the Energy Act 2008. OPRED requires that the decommissioning of pipelines must satisfy the requirements of the Petroleum Act, 1998, and that pipelines are assessed on a case-by-case basis. Therefore, all feasible decommissioning options should be considered and included in a CA. A pipeline CA must take account of the safety, environmental, technical, societal and cost considerations of the

feasible options. Cost impact may only be considered a determining factor when all other criteria emerge as equal. The draft DP must be supported by an EA.

Under the Marine and Coastal Access Act 2009 (MCAA) (Her Majesty's (HM) Government, 2009) a licence application will be required at the time of decommissioning capturing the detail of all the proposed activities and assessing their impact.

Other relevant legislation includes:

- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (HM Government, 2001);
- The Offshore Chemicals Regulations 2002 (HM Government, 2002) (as amended);
- The Offshore Petroleum Activities (Oil Pollution Prevention and Control (OPPC)) Regulations 2005 (HM Government, 2005b) and as amended 2011;
- The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 (requiring an Oil Pollution Emergency Plan (OPEP)) (HM Government, 1998);
- The Pipelines Safety Regulations 1996;
- The Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (HM Government, 1999);
- Environmental Protection Act 1990 (HM Government, 1990);
- Special Waste Regulations 1996 (HM Government, 1996);
- Hazardous Waste (England and Wales) Regulations 2005 (HM Government, 2005a); and
- Trans-frontier Shipment of Waste Regulations (HM Government, 2007); and
- The EU Habitats Directive (92/43/EEC) and the EU Birds Directive (79/409/EEC) (further details are provided in Section 5.6).
- Scotland's National Marine Plan (NMP) in accordance with EU Directive 2014/89/EU (which came into force in July 2014)

The Scottish NMP comprises plans for Scotland's inshore (out to 12 nautical miles) and offshore waters (12 to 200 miles) as set out under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. The NMP represents a framework of Scottish Government policies for the sustainable development of marine resources. Marine planning policies within the NMP require that 'any plans for decommissioning of infrastructure should consider the potential for infrastructure life to be extended to support potential combustible gas imports and to accommodate the growth of carbon capture and storage networks for use in storage and enhanced oil recovery. Further details on the NMP are provided in Section 5.7

There are cross boundary lines associated with the Brynhild Field, such that there was a requirement for consultation with the Norwegian Regulator. It has been agreed with OPRED and MPE that the DP, CA and EA focus on the infrastructure laid within the UKCS only. Decommissioning of infrastructure within the Norwegian sector will be captured in the Disposal Plan. Exemption from the requirement for an impact assessment was granted by MPE on 20/6/17.

That said, any potential transboundary impacts do need to be considered in the EA (e.g. the potential for transboundary impacts in the event of a hydrocarbon spill) whilst any waste shipped to a country other than the UK comes under the Trans-Frontier Shipment of Waste Regulations.

2. STAKEHOLDER ENGAGEMENT

Consulting with stakeholders is an important part of the decommissioning impact assessment process as it allows any concerns or issues which stakeholders may have, to be communicated and addressed. In March 2019, as part of the informal stakeholder engagement process Lundin issued a Scoping Report to a number of stakeholders. The Scoping Report provided an overview of: the Brynhild Field; the proposed decommissioning activities (including results of the CA); the baseline environment; and the aspects to be considered in the EA. Stakeholders were invited to comment on the Scoping Report with respect to any concerns they may have. Table 2-1 identifies the stakeholders that were issued the Scoping Report and captures the comments received.

In addition to issuing the Scoping Report, Lundin have held informal stakeholder engagement sessions with the OPREDs Offshore Decommissioning Unit (ODU) and OPREDs Environmental Management Team (EMT). Comments received on the Scoping Report and issues raised during the separate meetings are summarised in Table 2-1.

The formal statutory and public consultation process will be triggered by the submission of the consultation draft of the DPs and supporting documents (including this EA report) to OPRED. As the project progresses further consultation will be undertaken as required.

Table 2-1: Third Party Consultations.

Third party	Date	Comments / issues / concerns
OPRED ODU	Meeting 25/01/19	• Lundin provide an overview of the Brynhild Field to OPRED ODU. • It was agreed that the DP scope will be limited to infrastructure in the UKCS, but for completeness documentation should include brief description of infrastructure in the NCS. *Information on the infrastructure within the NCS is captured within the DP and therefore not expanded on in the EA.* • It was agreed that the RED/AMBER/GREEN approach to CA would be used. • OPRED ODU advised that the EA should be proportionate to the size of the project.
OPRED EMT	Meeting 20/02/19	• Discussions held regarding flushing of the pipelines. *Details provided in Section 2*. • No issues raised. Advised that the EA should be proportionate to the size of the project.
Marine Science Scotland (MSS)	Response to the Scoping Report received on 5/4/19	• No opposing comments on the proposed strategy. • Advice provided on availability of new features in NMPi (National Marine Plan interactive). *Latest NMPi data has been used to support the EA where relevant.*
Joint Nature Conservation Committee (JNCC)	Response to the Scoping Report received on 10/04/19	• Provision of advice on use of survey data in the EA *Survey data has been used to support the EA* • Advised to minimise the introduction of new hard substrate materials to the seabed. *The recommended option for exposed sections of pipelines aligns with this recommendation.*

Third party	Date	Comments / issues / concerns
Global Marine Systems Limited	Response to the Scoping Report received on 10/04/19	• No opposing comments on the proposed strategy.
Scottish Fishermen's Federation (SFF)	Response to Scoping Report received on 29/05/19	• SFF advised that with respect to pipeline cuts their preference is 'for these to be made below the mudline and to have a covering of rock level to the mudline for additional stability'.

3. PROJECT DESCRIPTION

3.1 Infrastructure Overview

Figure 1-2 shows a representative schematic of the Brynhild Field.

The total length of the production (PL3083) and umbilical (PLU3085) lines located within the UKCS is 11.97 km and 12.06 km respectively. For the most part these lines are trenched and buried within the same trench. The total length of the water injection (PL3084) pipeline located within the UKCS is 12.28 km. This pipeline is also trenched and buried for most of its length.

Both trenches have spot rockdump associated with them as summarised in Table 3-1 and illustrated in Figure 3-1. Where rock cover has been applied, the berm profile has been designed and specified to be over trawlable. Apart from at the approaches to the Haewene Brim FPSO, the pipelines and umbilical are well buried along the route to greater than 0.6 m top of pipe with no known exposures.

Table 3-1: Summary of Existing Rockdump Profiles.

Parameter	Production pipeline/umbilical	Water injection pipeline
Rockdump on UKCS and in Norwegian waters		
Total length of rock berms along full length of lines	2,585 m	1,275 m
Total number of rock locations along full length of lines	26	10
Range of lengths of rock berms along full length of lines	10 m – 194 m plus 625 m on production line at approach to Haewene Brim FPSO and 1,021 m on umbilical at approach to Haewene Brim FPSO	5 m – 298 m plus 622 m on approach to Haewene Brim FPSO
Rockdump on UKCS only		
Total length of rock berms in UKCS	2, 059 m	1,039 m
Total number of rock locations in UKCS	9	7
Range of lengths of rock berms in UKCS	12-194 m plus 625 m on production line at approach to Haewene Brim FPSO and 1,021 m on umbilical at approach to Haewene Brim FPSO	5-205 m plus 622 m on approach to Haewene Brim FPSO

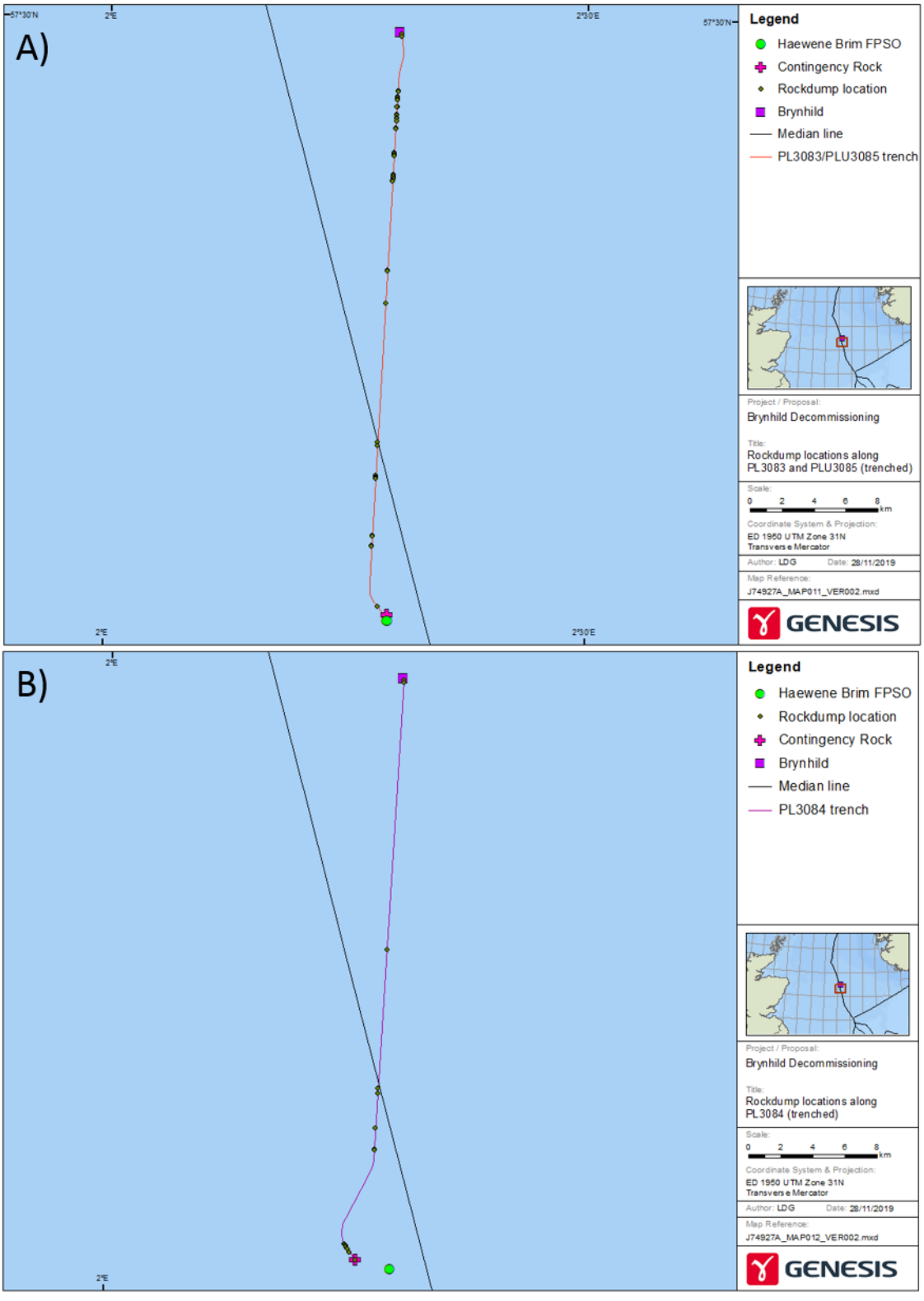


Figure 3-1: Location of Existing and Contingency Rockdump on A) the Production Pipeline and Umbilical and B) the Water Injection Pipeline.

3.1.1 Production Pipeline and Umbilical on Approach to the Haewene Brim FPSO

Figure 3-2 illustrates the approach of the production pipeline (a pipe-in-pipe structure) and umbilical at the Haewene Brim FPSO. There is a Pipeline End Termination (PLET) structure on the production pipeline within the FPSO's 500 m safety zone. On approach to the PLET, the production pipeline remains trenched, however for a length of 675 m it is rockdumped rather than backfilled.

A flexible jumper (130 m) connects the PLET to a Riser Base Manifold (referred to as the Brynhild RBM) via two Flexible Jumper Support Structures (FJSS). The production jumper is protected with rock cover. Due to the main Pierce production pipeline tying into the Brynhild RBM, the decommissioning of this structure is out with the scope of this decommissioning project and will be addressed as part of the Pierce DP.

The PLET and associated FJSSs have three protection covers (Glass Reinforced Plastic (GRP)) associated with them. Two GRP protection covers protect the tie-ins at the Brynhild RBM. Rockdump was added around the skirts of the GRP covers to keep them in position. Rock volumes are estimated to be 2,100 te at the PLET and 2,000 te at the Brynhild RBM location.

Summary details of the structures described are provided in Table 3-2. Photographs of the rockdump holding the GRP protection covers in place are presented in Figure 3-3.

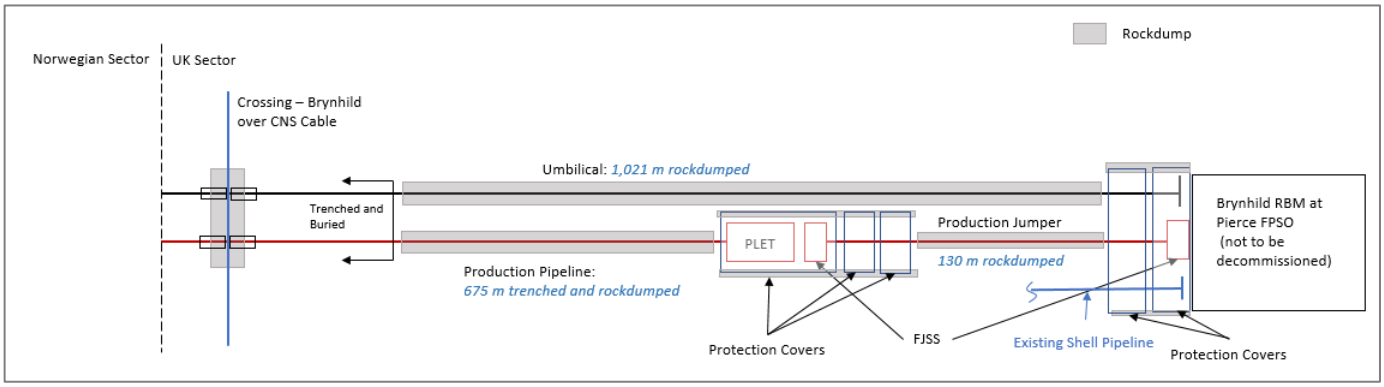


Figure 3-2: Representative Schematic of Production Pipeline and Umbilical on Approach to the Haewene Brim FPSO.

Table 3-2: Subsea Structures to be Recovered.

Structure	Number	Dimensions (m)/	Total Weight (Te)
PLET	1	5.4 (L) x 1.6 (W) x 2.3 (H)	6.38
PLET support frames	2	13.5 (L) x 8.0 (W) x 0.1(H)	37
FJSS at PLET	2	2.8 (L) x 1.2 (W) x 2.0 (H)	2.72
GRP cover at PLET	3	11.0 (L) x 4.0 (W) x 2.6 (H)	30.81
FJSS at RBM	1	2.8 (L) x 1.2 (W) x 2.0 (H)	2.75
GRP covers at RBM	2	11.0 (L) x 7.6 (W) x 2.6 (H)	32.88

Figure 3-3: Images Showing Rockdump Levels at the PLET.

The umbilical exits the trench 1,021 m from the Brynhild RBM and is rock dumped for this full length.

Following Cessation of Production (CoP), the hydrocarbons within the production pipeline were flushed down one of the Brynhild wells (well BRY-2) and subsequently flushed three times with freshwater containing oxygen scavenger. The pipeline is currently filled with freshwater containing oxygen scavenger and is expected to contain minor (residual) volumes of hydrocarbons. As the flushes were injected into the reservoir it was not possible to take samples during the flushing activities.

When operational the Brynhild pipeline was operated above the Wax Appearance Temperature (30^{o}C) for the entire flowing period and as such only negligible amounts of wax are expected to be present in the pipeline.

Prior to commencement of the offshore decommissioning campaign, flushing of the umbilical cores will be completed in line with approved permit applications. Results of the flushing activities will be shared with OPRED.

3.1.2 Water Injection Pipeline on Approach to the Haewene Brim FPSO

Figure 3-4 illustrates the approach of the water injection pipeline at the Haewene Brim FPSO. The water injection pipeline exits the trench as it approaches the FPSO, such that 622 m is covered with rockdump. The main water injection pipeline is separated from a water injection jumper via a tie-in flange. On approach to the tie-in flange, 30 m of the water injection pipeline is surface laid and protected with mattresses (five in total). The Brynhild DP scope includes the pipeline up to this flange; any infrastructure between it and the FPSO will be decommissioned as part of the Pierce Field decommissioning activities. The five mattresses will be recovered, and the exposed 30 m section will be decommissioned in line with the results of the CA carried out for the water injection pipeline (see Section 4). The water injection pipeline is currently filled with inhibited seawater.

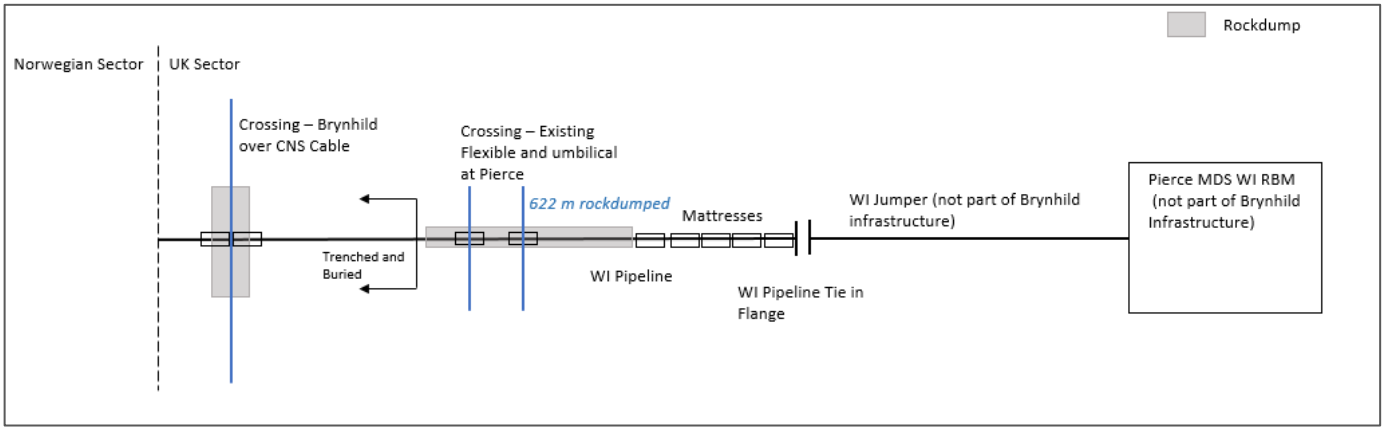


Figure 3-4: Representative Schematic of Water Injection Pipeline on Approach to the Haewene Brim FPSO.

3.2 Proposed Activities

3.2.1 Preparatory Works

As mentioned previously the production pipeline is currently filled with freshwater containing oxygen scavenger having previously been flushed three times. It is expected that the line may contain minor (residual) volumes of hydrocarbons. The water injection line is currently filled with inhibited seawater.

Lundin propose to flush the umbilical cores prior to decommissioning. The cores will be flushed from the well location. To allow a 'roundflush' of the chemical cores and therefore return of the fluids to the vessel, intervention activities will be required at the Brynhild RBM. During these intervention activities approximately 10 litres of fluids comprising a mix of scale inhibitor, asphaltene inhibitor, demulsifier and control fluids will be discharged. Prior to carrying out the intervention activities at the RBM, Lundin will submit a permit application to OPRED requesting consent to discharge these chemicals. The umbilical also contains a methanol core, which will not be flushed.

The cores will be flushed by pumping MEG/freshwater (50:50 mix) from a vessel located at the Brynhild Field (within the NCS). Fluids will be returned to the vessel, collected, stored and transported to shore for treatment and disposal. Following flushing the standard Brynhild RBM configuration will be reinstalled.

During decommissioning some of the MEG/Water mix and methanol will be released when the umbilical ends are cut.

3.2.2 Plug and Abandonment

As the activities associated with the plugging and abandoning of the wells will take place on the NCS details are not provided here.

3.2.3 Decommissioning Activities

All structures and stabilisation features to be recovered are located within the Haewene Brim 500 m exclusion zone. In addition, any remedial activities to be carried out on the exposed pipeline and umbilical ends will also be within the 500 m zone.

Subsea Structures

Apart from the two GRP covers associated with the Brynhild RBM it is proposed to recover all the structures detailed in Table 3-2. It is expected that the two GRP protection covers located at the Brynhild RBM will be temporarily removed to enable the Brynhild infrastructure beneath to be recovered as part of the decommissioning programme. Following removal of the Brynhild infrastructure the two covers will be reinstated to retain protection to the Pierce tie-in, with the responsibility for the decommissioning of the GRP covers becoming the responsibility of the Pierce operators at the end of field life.

Stabilisation Features

As detailed in the DP (Table 2.5) there are 36 mattresses associated with the Brynhild infrastructure located within the UKCS. Of these 36 mattresses, 31 provide stabilisation under the pipelines and umbilicals and are covered with rockdump. It is therefore proposed to decommission these mattresses *in situ*. The remaining five mattresses occur within the 500 m zone and provide protection to the water injection pipeline. These five mattresses will be recovered as part of the DP.

Within the UKCS there is an estimated 432 x 25 kg grout bags associated with the buried mattresses (Table 2.5 of DP). As they are buried beneath rock cover it is proposed to decommission these grout bags *in situ*. There are no grout bags associated with the five mattresses to be recovered.

It is proposed to decommission all the rockdump detailed in Table 3-1 *in-situ* (equates to a total volume of 40,255 te on the UKCS- see Table 2.5 of DP). It is not known if it will be necessary to relocate some of the rockdump associated with the GRP protection covers in order to allow them to be recovered. The EA assumes a worst case whereby dredging of the rockdump will be required. Relocation of the rockdump across an area extending 1 m on each side of the protection covers has been assumed.

Pipelines and Umbilicals

A CA was carried out to determine the optimal approach for decommissioning the two pipelines and the umbilical, the results of which are summarised in Section 4. Full details are provided in the CA Report submitted in support of the DP. In keeping with the results of the CA, Lundin, plan to decommission the pipelines and umbilical *in situ* whilst cutting and removing the exposed ends. As contingency options, trench and bury; and rock cover of the ends will be taken through as first and second contingency options respectively. If the option to rock dump the exposed ends is selected, it is estimated that a maximum of 640 te of rock would be required: 110 te on the end of the umbilical 175 te on the end of the water injection pipeline and 355 te on the end of the production pipeline. All rock would be laid within the Haewene Brim FPSO 500 m exclusion zone and will be laid next to existing rock berms as shown in Figure 3-1. Details of the exposed ends for each line are presented in Table 3-3. The rock covered flexible production jumper (130 m) connecting the PLET to the Brynhild RBM will be decommissioned *in situ*.

Table 3-3: Summary of Exposed End Sections.

Structure	Length of line in UKCS (km)	Exposed length in UKCS (m)
Production pipeline (PL3083)	11.97	0
Production jumper (PL3083)	0.138	40.5[1]
Umbilical (PLU3085)	12.06	21.3[2]
Water injection pipeline (PL3084)	12.28	30[4]

[1]40.5 m becomes exposed on the seabed when the GRP protection covers are recovered at the Brynhild RBM (18.5m) and PLET (22m).

[2]21.3 m becomes exposed on seabed once the GRP covers are recovered at the Brynhild RBM.

[3]Length of line that will be exposed when the five surface laid mattresses laid near the tie-in flange are recovered.

3.2.4 Vessel Use

At the time of writing, specific vessels have not yet been identified, however, the types of vessel required are well known and standard performance characteristics for typical vessels have been used for the purposes of estimating energy consumption and emissions to air. By estimating the fuel use based on generic vessel types (Institute of Petroleum Guidelines (IoP), 2000 and industry experience) and the likely duration of the work programme for each vessel, estimates of fuel consumption can be made. Estimates are shown in Table 3-4.

Table 3-4: Anticipated Vessel Requirements and Fuel Usage.

Vessel type	Duration (days)[2]	Fuel consumption rate (te/day)[3]	Fuel usage (te)
Subsea decommissioning			
ROVSV	11	21.5	236.5
Rockdump vessel[1]	7	15	105
Seabed clearance and over trawlability surveys			
Trawler (trawl trials: if used)	5	4	20
Post decommissioning survey (assumes two post decommissioning surveys)			
Survey vessel	37	24	888
Total fuel use			1,249.5

[1]Vessels associated with rock dumping of the exposed ends are presented here as they represent worst case impacts. Base case is that the exposed ends will be cut and recovered.

[2]Vessel days provided are worst case estimates and include mobilisation, transit, working days and a 10% allowance for waiting on weather. Prior to contract award it is difficult to determine accurately.

[3]Fuel consumption rates are based on vessels at work. It is acknowledged that when vessels are in port preparing to mobilise, fuel consumption will be much lower. Final vessel days will be captured in the Justification Document supporting the Marine Licence to be submitted prior to commencement of offshore activities.

3.2.5 Survey and Monitoring

A post decommissioning site survey will be carried out on final completion of all decommissioning works. Surveys will be undertaken along all pipeline routes and at all sites where structures have been removed. Any significant debris will be recovered for onshore recycling or disposal. Independent verification of the seabed state will be obtained for the pipeline areas and installation locations and evidence of clearance will be provided to all relevant governmental and non-governmental organisations.

Inspections of the trenches will be carried out to confirm that no exposures develop. In addition, should surveys will determine the stability of the existing rock and any additional rock that may be added. The timeline for inspections will be agreed with OPRED.

The requirement for a post decommissioning environmental seabed survey will be discussed with OPRED. If deemed necessary, the objective of the survey will be to identify any chemical or physical disturbances to the seabed following decommissioning and to provide a baseline from which future surveys can be compared. The survey reports will be submitted to OPRED and a post monitoring survey regime will be agreed.

3.3 Schedule

An indicative schedule for the proposed Brynhild Decommissionig Project is shown in Figure 3-5.

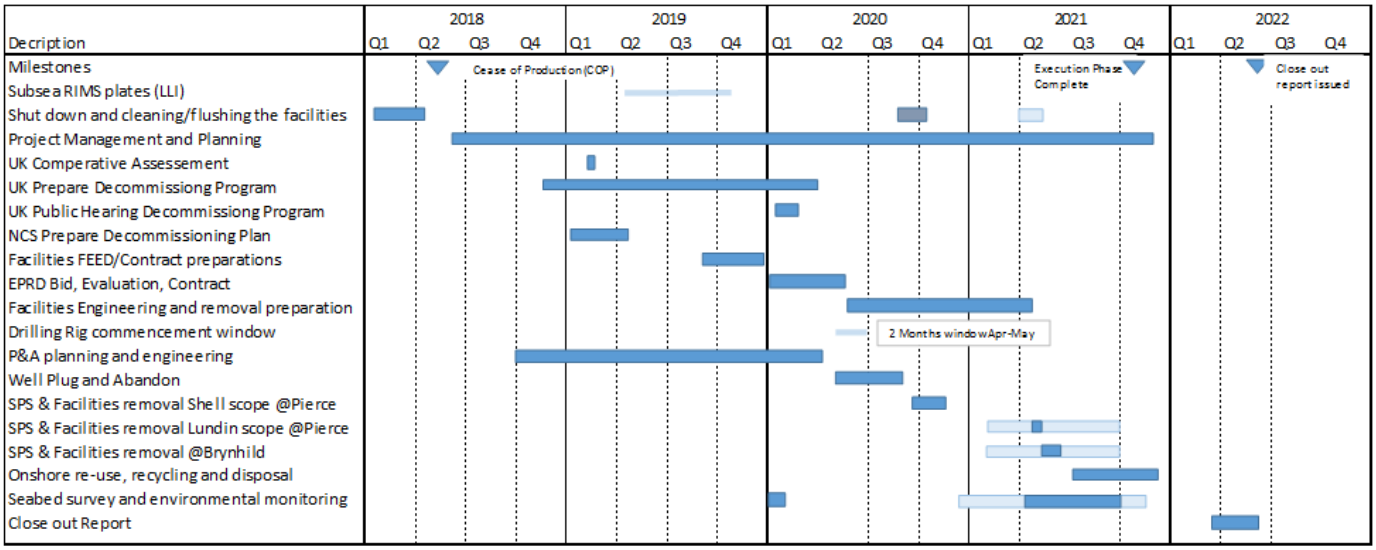


Figure 3-5: Indicative Schedule for the Brynhild Decommissioning Project.

4. COMPARATIVE ASSESSMENT

OPRED Guidance Notes on the decommissioning of offshore installations and pipelines (BEIS, 2018) recognise that removing pipelines already buried to a sufficient depth may not be the preferred decommissioning option and therefore provide for a case by case consideration of pipeline decommissioning alternatives on the basis of a CA.

The CA were carried out in line with the Oil and Gas UK (OGUK) Guidelines for CA (OGUK, 2015). The CA Report (Lundin, 2019), submitted in support of the draft DP provides full details of the assessment carried out for the decommissioning of the Brynhild pipelines and umbilical whilst this chapter summarises the process followed and the results.

Prior to the CA a pre-screening of a wide range of the potential decommissioning options for the pipelines and umbilical was carried out. Options assessed included:

Option 1A:	Total removal by reverse reeling.
Option 1B:	Total removal by reverse s-lay.
Option 1C:	Total removal by cut and lift.
Option 2A:	Partial remediation: rock cover exposed sections.
Option 2B:	Partial remediation: trench and bury exposed sections.
Option 2C:	Partial remediation: cut and remove exposed sections.
Option 3:	Do nothing.

The total removal options (1A to 1C) refer to total removal of the pipelines and umbilical. The partial remediation options (2A to 2C) refer to leaving the buried sections of pipeline and umbilical *in situ* and remediating the exposed sections whilst Option 3 involves no activity and leaving the pipelines and umbilical as found. Option 1B and Option 1C were both screened out during the pre-screening exercise which involved a qualitative assessment considering safety, environment, technical, societal and economic impacts. Further detail on the pre-screening assessment is provided in the CA Report submitted with the DP.

The colour coding methodology for CA's (Red/Amber/Green) as described in the OGUK Guidelines (OGUK, 2015) was followed. Using this methodology, the following criteria were assessed for Options 1B, Options 2A to 2C and Option 3:

- Technical Feasibility;
- Safety;
- Environmental;
- Societal; and
- Economic Risk.

All criteria were given an equal weighting.

The CA concluded that decommissioning *in situ* and cutting and removing exposed ends (Option 2C) was the most preferable option. However, this option was found to be only marginally better than Option 2A and 2B such that the CA proposed that all three partial remediation options could be carried through to the execution tendering stage.

Therefore, in keeping with the results of the CA, Lundin, plan to decommission the pipelines and umbilical *in situ* whilst cutting and removing the ends. As contingency options, trench and bury; and rock cover of the ends will be taken through as first and second contingency options respectively.

5. ENVIRONMENTAL BASELINE

This chapter provides an overview of the key environmental and socio-economic features in the vicinity of the Brynhild infrastructure that may be affected by the proposed decommissioning works.

5.1 Environmental Surveys

In 2010 Lundin commissioned Fugro to carry out a pre-installation pipeline route survey between the Brynhild Field and the Haewene Brim FPSO location (Fugro, 2011a, 2011b). In addition, Shell have shared the results from an environmental survey carried out at the Pierce Field in 2013 (Fugro, 2015). The findings from both these surveys have been used to support the baseline description.

As part of the 2010 Brynhild pipeline route survey, side scan sonar data were acquired across the survey area whilst an ROV camera system was used for ground-truthing at ten locations (Fugro, 2011a). In addition, underwater photography and benthic samples were taken from a number of stations. Environmental grab sampling was completed using a 0.1 m^2 dual van Veen grab.

As part of the 2013 Pierce Field survey, underwater photography and benthic samples were taken from a total of 27 stations (Fugro, 2015). In addition, four video transects were taken. As for the 2010 survey, environmental grab sampling was completed using a 0.1 m^2 dual van Veen grab.

Location of the sampling stations for both surveys are shown in Figure 5-1.

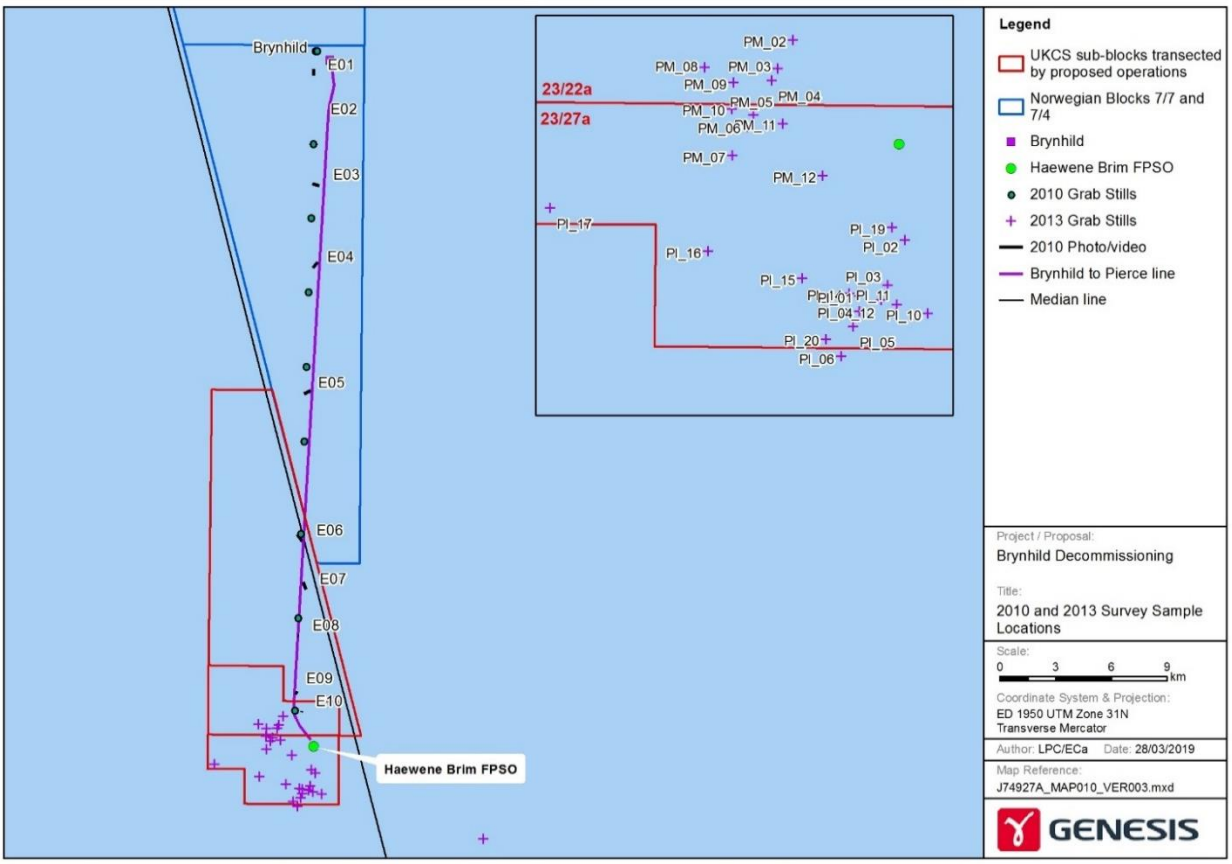


Figure 5-1: Sampling Stations Associated with the Environmental Surveys.

5.2 Bathymetry

The Brynhild pipeline route survey covered an area of 36.5 km x 1 km (Fugro, 2011a). Across this area bathymetric data was acquired using single beam and multibeam echo sounders. Water depths along the route vary from 80 m (at the Brynhild Field) to 86.5 m at the Haewene Brim FPSO location (Fugro, 2011a). The general morphology along the pipeline route was considered to be 'gently undulating with minor ridges and troughs' whilst the general gradient along the route is < 5º.

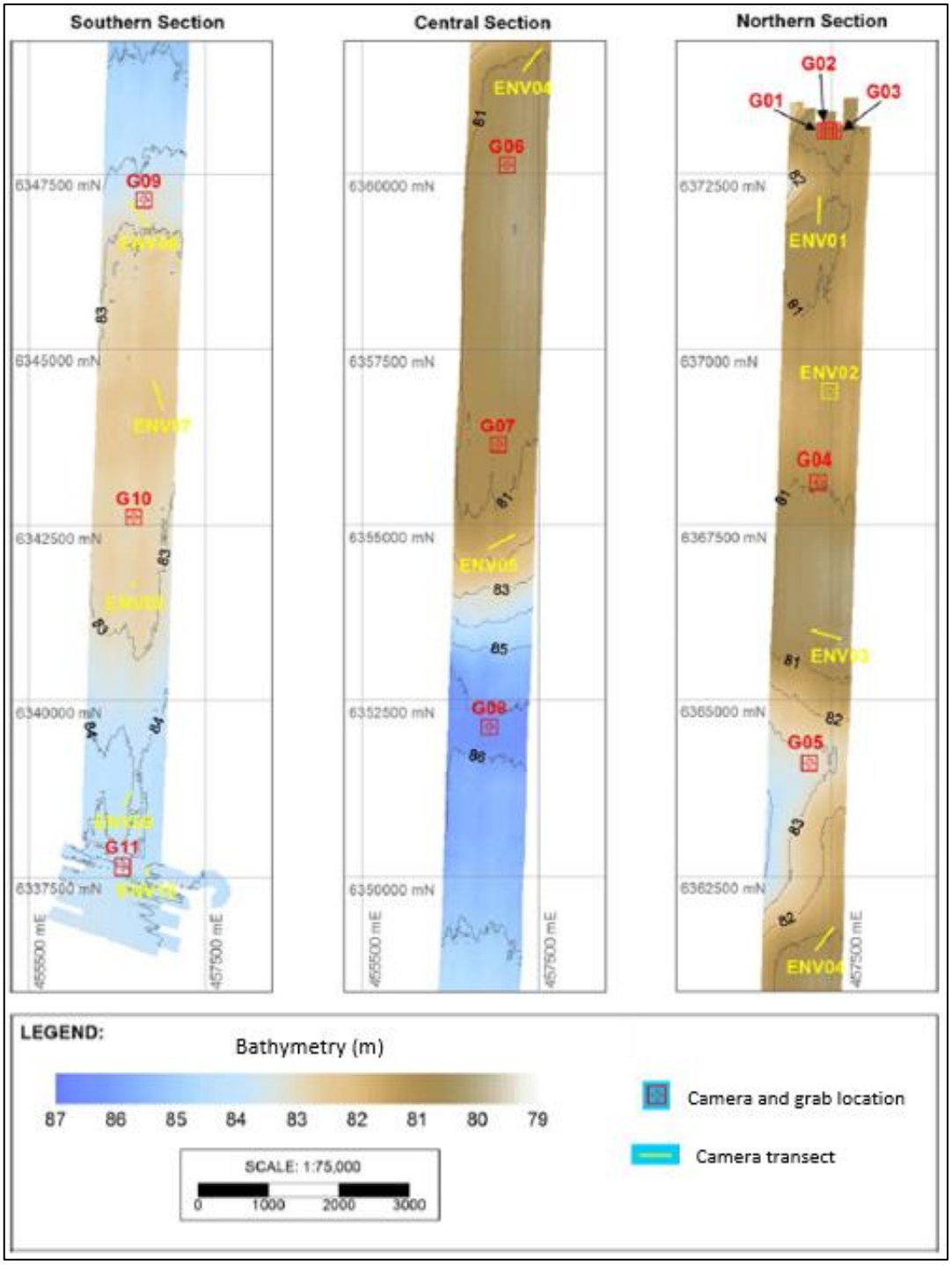


Figure 5-2: Bathymetry Along the Brynhild Pipeline Route (Fugro, 2011a).

5.3 Metocean Conditions

Winds can occur from any direction in the area, but the main winds throughout the year are from the south and west. These wind directions are particularly prevalent in the late autumn and through the winter months (October-March). The predominant wind speeds throughout the year are moderate breezes at 6 – 10 m/s, although this is variable, and the strongest winds tend to occur in winter months.

The climate in the North Sea is strongly influenced by the inflow of oceanic water from the Atlantic Ocean and the large scale westerly air circulation which frequently contains low pressure systems. The average sea surface temperature is 8 ºC at the seabed and 10 ºC at the surface (Scottish Government National Marine Plan Interactive (NMPi), 2019).

The mean spring tidal range within the region ranges from 0.1 – 1.0 m, and the annual mean significant wave height within the area ranges from 2.11 – 2.40 m (Scottish Government NMPi, 2019).

5.4 Sediments

Side Scan Sonar data along the pipeline route showed the seabed to have predominantly low to moderate acoustic reflectivity, indicative of silty sand. Patches of higher reflectivity were present throughout the survey area and these were interpreted as outcropping clay and / or gravelly / shell sediments. Seabed photography taken across the survey area was in broad agreement with the side scan sonar data (Fugro, 2011a). It was concluded in the survey report that, in accordance with the EUNIS (European Nature Information Service) Marine Habitat Classification system, two broad habitat types occurred along the route: Circalittoral Muddy Sand (EUNIS Code A5.26) and Circalittoral Mixed Sediment (EUNIS Code A5.44).

Sediment samples from the Pierce Field were dominated by sand, with a moderate proportion of fines (silt and clay) and minimal coarse (gravel and pebble) material, with some variation in sediment type between stations (Fugro, 2015). It was concluded in the survey report that, in accordance with the EUNIS classification, a single habitat ‘Deep Circalittoral Sand’ (EUNIS Code A5.27) was present across the entire Pierce Field survey area (Fugro, 2015).

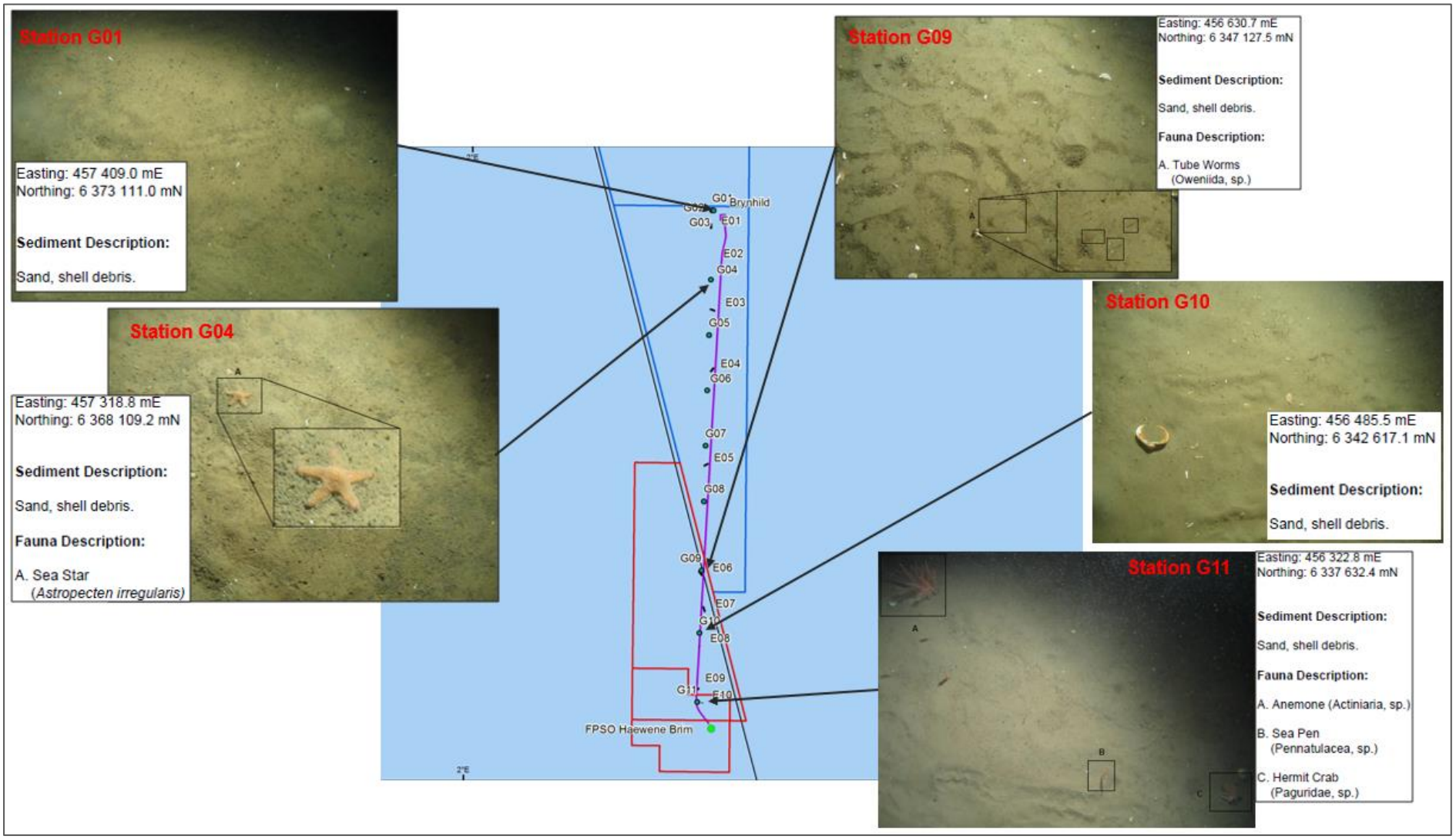


Figure 5-3: Sample Seabed Photographs Taken Along the Brynhild Pipeline Route (Fugro, 2011a).

Concentrations of hydrocarbons, barium and other metals across the survey area showed no evidence of contamination resulting from anthropogenic activities.

No Annex I habitats were identified across the surveyed area.

In addition to the summary information presented here, the description of sediments presented in the EA will consider the results from the 2013 survey carried out by Shell within the Pierce Field area (Fugro, 2015).

5.5 Biological Environment

5.5.1 Plankton

The planktonic community in the vicinity of the proposed decommissioning activities is typical of the CNS. The continual exchange of individuals with surrounding waters (Beare *et al*., 2002) means that the significance of impacts of any of the proposed activities or any potential accidental events on plankton in the area is expected to be low/negligible. Therefore, only an overview of the plankton communities in the area will be provided in the EA.

In both the northern and central areas of the North Sea, the dinoflagellate genus *Ceratium dominates* the phytoplankton community. There has been a gradual decrease in the abundance of the majority of diatom species (except *Thalassiosira* spp. numbers which have remained constant) whereas the dinoflagellate assemblage has continued to increase (Edwards *et al*., 2010).

Zooplankton species richness is higher in the northern and central North Sea than in the southern North Sea. In general, the zooplankton of the North Sea is dominated by small copepods, such as *Pseudocalanus elongatus*, *Acartia clausi* and *Temora longicornis*, and the larger copepod *Calanus finmarchicus* (Edwards and John, 1996). Of the larger zooplankton, representative taxa likely to be present in the area include euphausiids (krill), thaliacea (salps and doliolids) and siphonophores and medusae (jellyfish) (Edwards and John, 1996).

5.5.2 Benthic Communities

Bacteria, plants and animals living on or within the seabed sediments are collectively referred to as benthos. Activities that result in the disruption of the seabed such as the removal of subsea infrastructure can affect the benthic fauna (Clark, 1996).

A total of 139 discrete macrofaunal taxa were recorded across the samples taken as part of the 2010 survey (Fugro, 2011b). Of these 67 (48.2 %) were annelida, 31 (22.3 %) were crustacean, 26 (18.7 %) were molluscan, 9 (6.5 %) were echinoderms and 2 (1.4 %) were cnidarians. Representatives of Nemertea, Phoronida, Spinuncula and Tunicata comprised the 4 taxa (2.9 %) of the total belonging to the other phyla.

The benthic communities identified in the area are typical of the dominant taxa recorded in other surveys undertaken in similar North Sea habitats (Fugro, 2011b and references therein).

As part of the 2013 Pierce Field survey (Fugro, 2015) a total of 80 macrofauna samples were acquired, with a total of 238 discrete macrofaunal species. The macrofaunal species were dominated by polychaetes, crustaceans and molluscs. Annelids were the most abundant comprising 91% of individuals recorded. This is generally comparable to the data recorded during an earlier survey carried out in 2009 (Fugro, 2010).

Eight of the ten most abundant taxa observed across the survey area were polychaetes. The most abundant taxon within the dataset was the amphinomid polychaete *P. jeffreysii* (Fugro, 2015).

*Arctica islandica (*ocean quahog), a burrowing bivalve which is listed as threatened and/or declining by the OSPAR commission and a Priority Marine Feature (PMF) in Scottish offshore and territorial waters, was also recorded within the area. *A. islandica* are typically found beneath the surface of sandy sediments, in water depths of 4 m to 400 m. According to Strahl *et al*. (2001) they are known to settle up to 12 cm deep within the sediment. The species is considered to be at particular risk of bottom fishing gear, and, like other slow-growing animals, once their numbers have been reduced, the population can take a long time to recover.

During the 2009 survey (Fugro, 2010) juvenile *A. islandica* were recorded in very low numbers (1-2 individuals) in 4 out of 54 grab samples acquired at 18 stations. No adults were recorded. In comparison, juveniles were recorded in 47 out of 48 grabs obtained in the 2013 survey (Fugro, 2015), with between 1 and 27 individuals per sample (Fugro, 2015). Seven adults were observed in the 2013 grab samples. *A. islandica* is known to have sporadic recruitment such that it is possible that juvenile settlement has occurred between the timing of the two surveys, resulting in the recorded increase in abundance.

5.5.3 Fish and Shellfish

More than 330 fish species are thought to inhabit the shelf seas of the UKCS (Pinnegar *et al*., 2010). The Brynhild Development is located across two International Council for the Exploration of the Sea (ICES) rectangles: 44F2 and 43F2. Spawning and nursery grounds for a selection of commercial fish species known to occur within ICES rectangle 43F2 (within which the UKCS portion of the Brynhild infrastructure lies) are listed in Table 5-1.

Table 5-1 Spawning and Nursery Areas for a Selection of Fish Species within ICES Rectangle 43F2.

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lemon sole[1]				S	S	S	S	S	S			
Sandeel [2]	SN	SN	N	N	N	N	N	N	N	N	SN	SN
Cod [2]	SN	*SN	*SN	SN	N	N	N	N	N	N	N	N
Mackerel[2]	N	N	N	N	*SN	*SN	*SN	SN	N	N	N	N
Norway pout[1,3]	SNJ	*SNJ	*SNJ	SNJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Plaice[2]	*SN	*SN	SN	N	N	N	N	N	N	N	N	SN
Haddock[1,3]	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Blue whiting[2]	N	N	N	N	N	N	N	N	N	N	N	N
Anglerfish[2,3]	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Hake[2,3]	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ	NJ
Herring[2]	N	N	N	N	N	N	N	N	N	N	N	N
Ling[2]	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog[2]	N	N	N	N	N	N	N	N	N	N	N	N
Whiting[2]	N	N	N	N	N	N	N	N	N	N	N	N
Spotted ray[2]	N	N	N	N	N	N	N	N	N	N	N	N

Key: *S = spawning* **S = peak spawning* *N = nursery* *J = juveniles (i.e. 0 group fish)*

Sources: (1) Coull *et al.* (1998) (2) Ellis *et al.* (2012) (3) Aires *et al*. (2014)

A number of the species identified within the area are considered PMFs in Scottish territorial and/or offshore waters, specifically: anglerfish, herring, mackerel, cod, blue whiting, ling, Norway pout, sandeel and whiting (JNCC, 2014a).

5.5.4 Marine Mammals

Distribution maps based on telemetry data (1991 - 2012) and count data (1988 – 2012) indicate that neither grey seals or harbour seals are expected to occur in the vicinity of the proposed activities.

The distribution of cetacean species in UK waters has been compiled in the Atlas of Cetacean Distribution in North-West European Waters (Reid *et al.,* 2003). Six cetacean species occur regularly over large areas of the North Sea; harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), white-beaked dolphin (*Lagenorhynchus albirostris*), white-sided dolphin (*Lagenorhynchus acutus*), killer whale (*Orcinus orca*) and minke whale (*Balaenoptera acutorostrata*). A further four cetacean species, Risso's dolphin (*Grampus griseus*), common dolphin (*Delphinus delphis*), long-finned pilot whale (*Globicephala melas*) and sperm whale (*Physeter macrocephalus*), have also been reported regularly in the North Sea. In addition, 11 cetacean species have been recorded as occasional visitors to the North Sea (SMRU, 2002).

In the vicinity of the Brynhild infrastructure, four species of cetacean are sighted (Reid *et al*., 2003) in moderate to low densities (Table 5-2). Harbour porpoise are protected under Annex II of the EU Habitats Directive (92/43/EEC as amended by 97/62/EC).

Table 5-2: Sightings of Cetaceans in the Vicinity of the Brynhild Infrastructure (Reid *et al*., 2003).

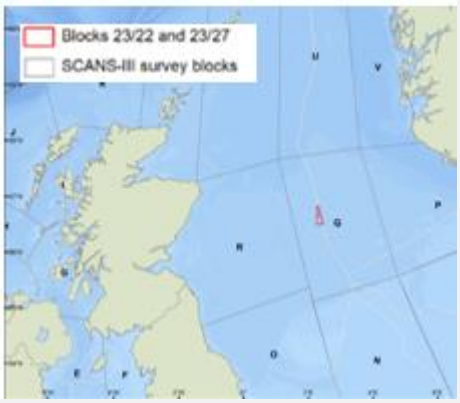
Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour porpoise							**2**					
Minke whale				**2**			**2**	**2**				
White-beaked dolphin					**2**		**2**					
Atlantic white-sided dolphin							**3**					
1 = High Density, 2 = Moderate Density, 3 = Low Density, Blank = No sightings												

A series of Small Cetacean Abundance in the North Sea (SCANS) surveys have been conducted to obtain an estimate of cetacean abundance in North Sea and adjacent waters, the most recent of which is SCANS-III (Hammond *et al*., 2017). Aerial and shipboard surveys were carried out during the summer of 2016 to collect data on the abundance of harbour porpoise, bottlenose dolphin, Risso's dolphin, white-beaked dolphin, white-sided dolphin, common dolphin, striped dolphin, pilot whale, all beaked whale species combined, sperm whale, minke whale and fin whale.

The Brynhild infrastructure is located within SCANS-III survey block Q. The extent of block Q and ariel survey estimates of animal abundance and densities (animals per km^2) within this area are provided in Table 5-3 (Hammond *et al*., 2017). The data supports the findings of Reid *et al*. (2003) with respect to the presence of harbour porpoise and minke whale in the area.

Table 5-3: Cetacean Abundance in SCANS III Survey Block Q (Hammond *et al*., 2017).

Species	Abundance	Density (animals / km^2)
Harbour porpoise	16,569	0.333
Minke whale	348	0.007



5.5.5 Seabirds

Using European Seabirds at Sea (ESAS) data collected over 30 years, seabird density surface maps have been generated to show particular species distribution in specific areas (Kober *et al.,* 2010). Data from the relevant maps has been summarised for the Brynhild area in Table 5-4.

Table 5-4: Predicted Seabird Surface Density (Maximum Number of Individuals/km^2) (Kober *et al*., 2010).

Species	Season	J	F	M	A	M	J	J	A	S	O	N	D
Northern gannet	Breeding												
Northern fulmar	Breeding												
	Winter												
Black-legged kittiwake	Breeding												
	Winter												
Little auk	Winter												
Herring gull	Winter												
Black-headed gull	Breeding												
Common guillemot	Breeding												
	Additional												
	Winter												
Atlantic puffin	Breeding												
	Winter												
All species combined	Breeding												
	Summer												
	Winter												

KEY	Not recorded	≤ 1	1– 5	5– 10	10- 15	15+

The Seabird Oil Sensitivity Index (SOSI) tool has been developed to identify areas where seabirds are likely to be most sensitive to oil pollution by considering factors that make a species more or less sensitive to oil-related impacts. The tool combines the seabird survey data with individual seabird species sensitivity index values. These values are based on a number of factors which are considered to contribute towards the sensitivity of seabirds to oil pollution, and include:

- Habitat flexibility (the ability of a species to locate to alternative feeding grounds);
- Adult survival rate;
- Potential annual productivity; and
- The proportion of the biogeographical population in the UK (classified following the methods developed by Certain *et al.,* (2015).

The combined seabird data and species sensitivity index values were summed at each location to create a single measure of seabird sensitivity to oil pollution. The mean sensitivity SOSI data for the area is shown in Figure 5-4. For blocks with 'no data', an indirect assessment has been made (where possible) using JNCC guidance (JNCC, 2019). The data suggests that the infrastructure associated with the Brynhild Development occurs within an area considered to be of low sensitivity with regards to the impact of oil pollution on birds.

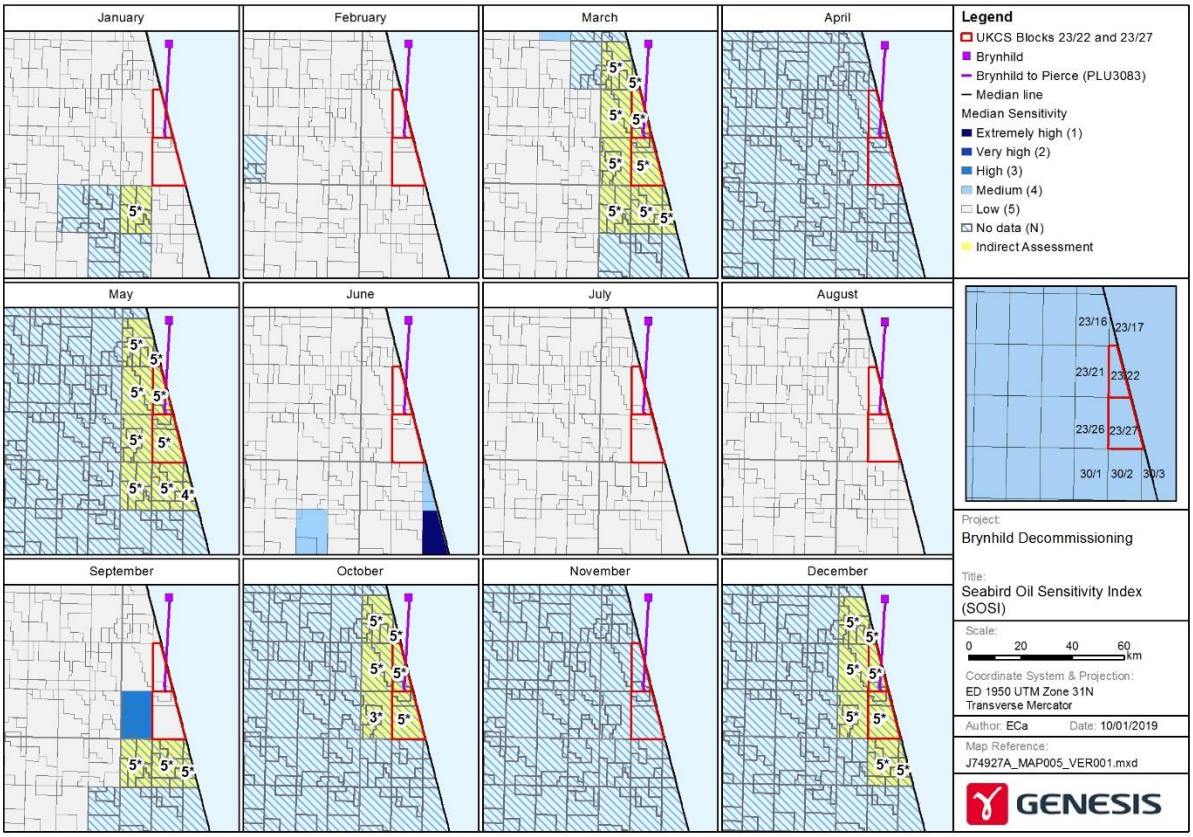


Figure 5-4: SOSI and Indirect Assessment Data Within Vicinity of the Brynhild Infrastructure.

5.6 Conservation Designations

A network of Marine Protected Areas (MPAs) is in place to aid the protection of vulnerable and endangered species and habitats, through structured legislation and policies. These sites include Special Areas of Conservation (SAC) and Special Protection Areas (SPA), designated under the EC Habitats Directive (92/43/EEC) and EC Birds Directive (2009/147/EC) respectively, along with Nature Conservation Marine Protected Areas (NCMPAs) designated under the Marine (Scotland) Act 2010 or the Marine and Coastal Access Act 2009. The Marine and Coastal Access Act 2009 (Part 5), enables the Department for Environment Food and Rural Affairs (Defra) to designate and protect Marine Conservation Zones (MCZs) in England and Wales. In Norway under the Norwegian Management Plan, areas referred to as Particularly Valuable Areas (PVA) are designated for the Norwegian Sector of the North Sea and Skagerrak. Figure 1-1 shows the location of the Brynhild infrastructure in relation to designated areas in the vicinity.

The closest designated area in UK waters is the East of Gannet and Montrose Fields Nature Conservation MPA (NCMPA), located approximately 48 km west of the Haewene Brim FPSO. This has been designated for the presence of *Arctica islandica* aggregations (including sands and gravels as their supporting habitat), and offshore deep-sea muds. At this distance none of the proposed activities are expected to impact on this area or any other designated areas in the UKCS.

The Brynhild infrastructure located within Norwegian waters occurs within an area considered valuable for its mackerel spawning grounds and is therefore considered a PVA. None of the proposed decommissioning activities (either in UK or Norwegian waters) are expected to have a significant impact on spawning mackerel in the area.

The EA considers the environmental impact of a worst case hydrocarbon spill (anticipated to be a release of fuel inventory from one of the vessels associated with the activities) on designated areas. Consideration will be given to the potential impact of such a spill on mackerel spawning given the proximity to the PVA (see Figure 1-1).

5.7 National Marine Plan

As mentioned previously (Section 1.4) the Scottish NMP comprises plans for Scotland's inshore (out to 12 nm) and offshore waters (12 to 200 nm) as set out under the Marine (Scotland) Act 2010 and the Marine and Coastal Access Act 2009. The plan represents a framework of Scottish Government policies for the sustainable development of marine resources and is underpinned by strategic objectives:

- Achieving a sustainable marine economy;
- Ensuring a strong, healthy and just society;
- Living within environmental limits;
- Promoting good governance;
- Using sound science responsibly.

These objectives are to be achieved through the application of the 21 'General Planning Principles' as summarised in Table 5-5.

Table 5-5: Scottish NMP's General Planning Principles.

Scotland's National Marine Plan Principles
GEN 1 General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of this Plan.
GEN 2 Economic benefit: Sustainable development and use which provides economic benefit to Scottish communities is encouraged when consistent with the objectives and policies of this Plan.
GEN 3 Social benefit: Sustainable development and use which provides social benefits is encouraged when consistent with the objectives and policies of this Plan.
GEN 4 Co-existence: Proposals which enable coexistence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision making processes, when consistent with policies and objectives of this Plan.
GEN 5 Climate change: Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.
GEN 6 Historic environment: Development and use of the marine environment should protect and, where appropriate, enhance heritage assets in a manner proportionate to their significance.
GEN 7 Landscape/seascape: Marine planners and decision makers should ensure that development and use of the marine environment take seascape, landscape and visual impacts into account
GEN 8 Coastal process and flooding: Developments and activities in the marine environment should be resilient to coastal change and flooding, and not have unacceptable adverse impact on coastal processes or contribute to coastal flooding.
GEN 9 Natural heritage: Development and use of the marine environment must: a) Comply with legal requirements for protected areas and protected species. b) Not result in significant impact on the national status of Priority Marine Features. Protect and, where appropriate, enhance the health of the marine area.
GEN 10 Invasive non-native species: Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.
GEN 11 Marine litter: Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.
GEN 12 Water quality and resource: Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive, Marine Strategy Framework Directive or other related Directives apply.
GEN 13 Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.
GEN 14 Air quality: Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.
GEN 15 Planning alignment A: Marine and terrestrial plans should align to support marine and land-based components required by development and seek to facilitate appropriate access to the shore and sea.

Scotland's National Marine Plan Principles
GEN 16 Planning alignment B: Marine plans should align and comply where possible with other statutory plans and should consider objectives and policies of relevant non-statutory plans where appropriate to do so.
GEN 17 Fairness: All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.
GEN 18 Engagement: Early and effective engagement should be undertaken with the general public and all interested stakeholders to facilitate planning and consenting processes.
GEN 19 Sound evidence: Decision making in the marine environment will be based on sound scientific and socio–economic evidence.
GEN 20 Adaptive management: Adaptive management practices should take account of new data and information in decision making, informing future decisions and future iterations of policy.
GEN 21 Cumulative impacts: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision making and plan implementation.

6. SOCIO-ECONOMIC ENVIRONMENT

6.1 Commercial Fisheries

The International Council for the Exploration of the Sea (ICES) divides the north-east Atlantic into a number of rectangles measuring 30 nm by 30 nm. Each ICES rectangle covers approximately one half of one quadrant i.e. 15 license blocks. The importance of an area to the fishing industry is assessed by measuring the fishing effort which may be defined as the number of days (time) x fleet capacity (tonnage and engine power). It should be noted that fishing activity may not be uniformly distributed over the area of the ICES rectangle.

The Brynhild infrastructure within the UKCS, is located within ICES rectangle 43F2. A review of the information collated by the Scottish Government suggests that fishing effort in the area is relatively low in comparison to the surrounding area. The average fishing effort per year in ICES 43F2 was 18.5 days between 2014 and 2018. This constitutes approximately 0.014 % of the overall UK fishing effort in days[1] (Scottish Government, 2019). A more detailed breakdown of effort per year is provided in Table 6-1.

Table 6-1: Annual Fishing Effort in ICES Rectangle 43F2.

Year	UK total effort (days)	Effort in rectangle 43F2(days)	% of UK effort
2014	131,478	32	0.024
2015	126,416	15.5	0.0123
2018	125,704	8	0.006
Average	127,866	18.5	0.014
Note: Data for 2016 and 2017 is not presented as < 5 vessels were active in the area such that the information is disclosive.			

Given the limited effort data, between 2014 and 2018, landings data are only available for 2014. In 2014 the total weight of landings was 688 te (live weight) with a value of £85,600. No landings for pelagic species was reported. From the information available fishing effort by UK vessels in the area of the Brynhild infrastructure is therefore considered to be low.

Figure 6-1shows the fishing intensity by fishing vessels ≥15 m in length using different types of fishing gear (therefore targeting different species) in the North Sea using Vessel Monitoring Systems (VMS) data (2009 – 2013). This data has been combined with landings data to develop GIS layers describing the spatial patterns of landings by the Scottish fleet. The data shows the position, time at a position, and course and speed of fishing vessels (Kafas *et al*., 2012). It can be seen that the most intense fishing effort is concentrated in different areas dependent on the fishing gear used. Demersal mobile gear was the most intensely used within rectangle 43F2 whereas pelagic fishing did not feature in the area. This data corresponds with the information presented above with respect to the lack of pelagic landings from the area.

[1] Note this value is based on landing values reported for ICES rectangles within which more than five UK vessels measuring 10 m were active. In those ICES rectangles where < 5 vessels were active the information is considered disclosive and is therefore not available. Note information presented relates only to 2014, 2015 and 2018 as there was no information available for 2016 and 2017.

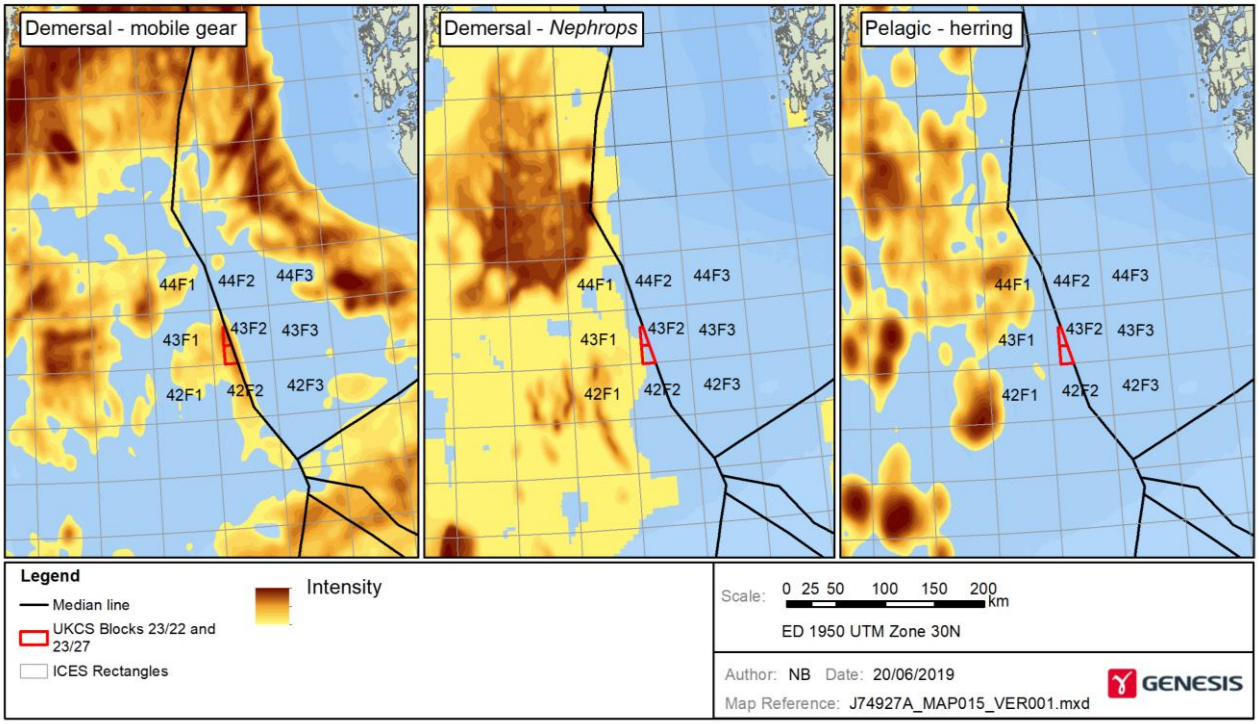


Figure 6-1: VMS combined data from 2009 – 2013 (Kafas *et al.*, 2012).

6.2 Other Activities in the Area

Figure 6-2 shows other oil and gas installations in the area. The Lomond and Erskine platforms are approximately 15.5 km and 19 km respectively from the Haewene Brim end of the Brynhild infrastructure. The Mungo and Lomond platforms are approximately 22.5 km and 24 km respectively from the Brynhild Field. At these distances none of the proposed decommissioning activities will impact on these installations.

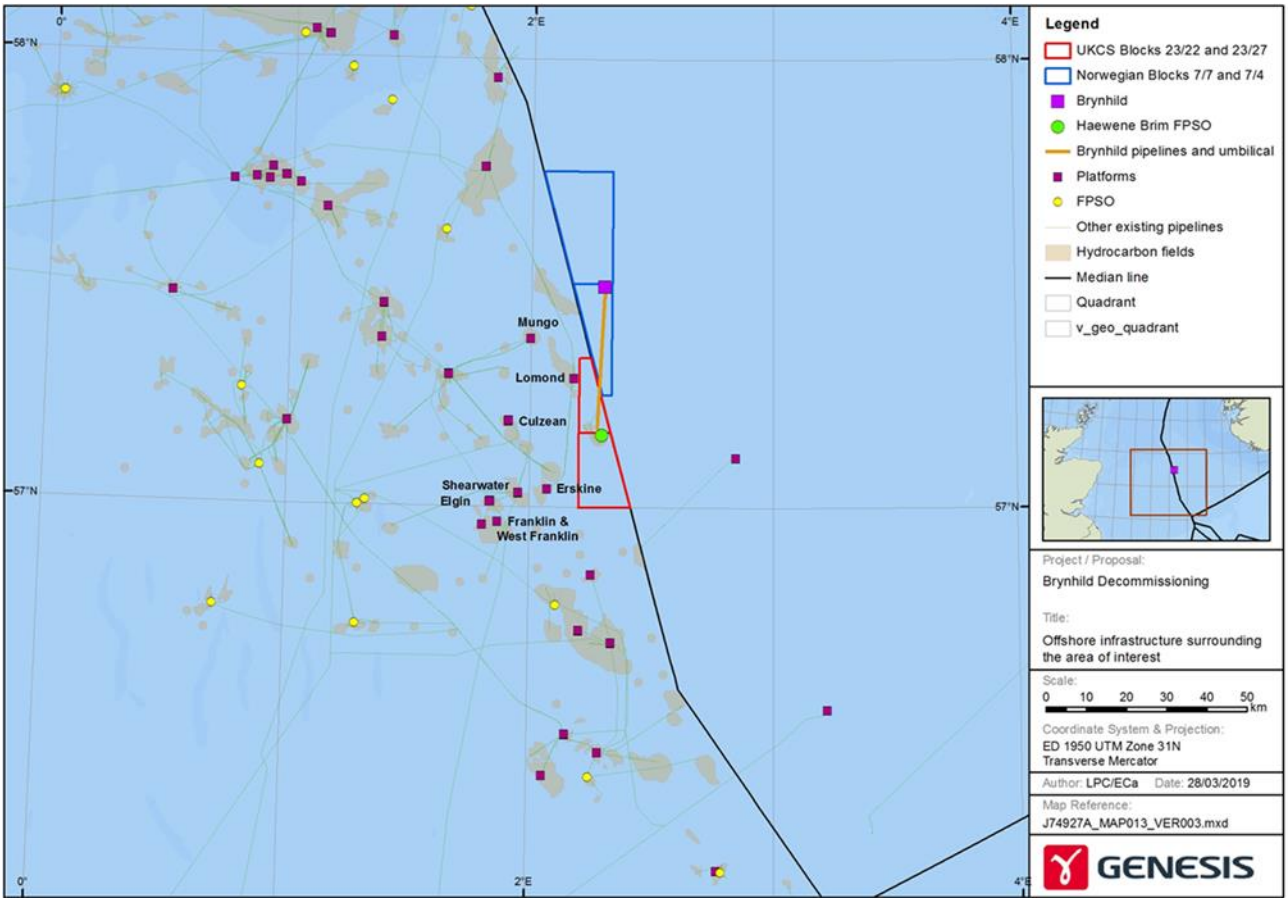


Figure 6-2: Other Oil and Gas Activities in the Area.

According to the Oil and Gas Authority (OGA) (2016b), shipping densities within Block 23/27a are considered low.

There are no telecommunications cables, aggregate extraction areas, military exercise areas or renewable energy developments within the vicinity of the proposed decommissioning activities (Scottish Government NMPi, 2019).

7. SCOPING OF POTENTIAL ENVIRONMENTAL IMPACTS

7.1 Impact Assessment Methodology

In order to determine the significance of impact of the proposed decommissioning activities an ENVID Workshop was undertaken following a structured methodology. The results of the ENVID help to scope out those impacts not considered significant, such that the EA focuses on those that have a significant impact. Aspects considered in the ENVID for the different activities included:

- Physical presence/interaction with other sea users;
- Seabed and habitat disturbance;
- Under water noise impacts;
- Discharges to sea;
- Atmospheric emissions;
- Waste; and
- Accidental events.

Where relevant the following environmental receptors were considered in the ENVID for each activity:

- Air quality;
- Water quality;
- Plankton;
- Fish;
- Seabirds;
- Landfill;
- Fisheries;
- Local communities (e.g. yard activities etc);
- Climate;
- Sediment quality;
- Benthic communities;
- Marine mammals;
- Designated areas;
- Resource availability;
- Shipping;
- Cultural heritage (e.g. wrecks).

During the ENVID, the significance of the environmental/social impact of planned activities on each of the susceptible receptors was derived by considering the 'Receptor Sensitivity' in relation to the 'Magnitude of Effect' of the aspect. This was carried out by applying the Environmental and Socio-Economic Impact Assessment (ESIA) methodology described in Appendix A (Section 11).

Worst case accidental events were also identified and assessed. To determine the environmental and social risk of an unplanned event, firstly the significance of the environmental impact of the event was determined. The likelihood of the unplanned event was then considered. Finally, a level of environmental risk (low, medium or high) was assigned by combining the impact significance and the likelihood of the event occurring using the Environmental and Socio-Economic Risk Assessment (ESRA) matrix presented in Appendix A (Section 11).

The results from the ENVID workshop are presented in Appendix B (Section 12). Applying industry standard mitigation measures as summarised in Appendix B, the impact of significance associated with each of the planned activities was considered to be low such that any environmental and social impacts are considered to be negligible.

Of the unplanned events that were assessed in the ENVID workshop, the significance of impact of a release of diesel inventory from one of the vessels was considered to be moderate, such that it could result in discernible environmental and social risks. The likelihood of such an event was considered to be remote, in that it was recognised that a similar event has occurred elsewhere but is unlikely to occur during this project with the application of current industry standard practices. The significance of impact of other unplanned events identified in the workshop (e.g. dropped objects) was considered to be low.

7.2 Scoping

Using the results of the ENVID, it was determined that the Impact Assessment (Chapter 8) will focus on those planned activities that result in a disturbance to the seabed. Though not considered significant, the impact of waste production is also considered further. In addition, the impacts associated with an accidental release of diesel inventory from one of the vessels is discussed. The following sections provide an overview of the other aspects considered in the ENVID and a justification as to why a detailed assessment of their impacts has not been provided.

7.2.1 Physical Presence of Vessels

Impact on Other Sea Users

The vessels required for the proposed decommissioning activities have the potential to interact with other sea users (e.g. ships and fishing vessels) when on location. However, these impacts are not considered significant due to:

- the minimal nature of the campaign;
- the fact that the majority of the activities will take place within an existing 500 m zone;
- other sea users being notified of vessel movements; and
- vessels using navigational aids including radar, lighting and Automatic Identification Systems (AIS).

Therefore, the impact of the physical presence of vessels on other sea users is not considered further.

Impact on Marine Mammals and Birds

With respect to the presence of the vessels on fauna in the area, the impact on marine mammals and birds has been considered.

As the activities will be taking place in a well-developed oil and gas region, it is expected that marine mammals have been habituated to vessel activity in the area. In addition, the evidence for lethal injury from boat collisions with marine mammals suggests that collisions with vessels are very rare (Cetacean Stranding Investigation Programme (CSIP), 2011). Out of 478 post mortem examinations of harbour porpoise in the UK carried out between 2005 and 2010, only four (0.8 %) were attributed to boat collisions. Therefore, though marine mammals are known to occur in the area, any impacts are not considered significant such that they are not discussed further.

Evidence suggests that the presence of the vessels could cause some bird species to be displaced from their foraging area. For example, auk species (e.g. guillemot, little auk) are believed to avoid vessels by up to 200 to 300 m but gull species (e.g. kittiwake, herring gull and great black-backed gull) are attracted to the presence of them (Furness and Wade, 2012). Seabird densities in the North Sea are reported to be seven times greater within 500 m of a platform. Lights are known to attract seabirds, however increased food availability at the installation and the availability of roost sites may also be a factor (Weise *et al*. 2001).

Though there is evidence that birds may be impacted by vessels the impact is not considered significant given:

- the very small proportion of their overall available habitat that will be occupied by the vessels;
- the very short duration that the vessels will be on site; and
- the close proximity of the activities to the Haewene Brim FPSO and other oil and gas related vessels and platforms.

Therefore, though birds are known to occur in the area, any impacts are not considered significant such that they are not discussed further.

7.2.2 Physical Presence of Infrastructure Decommissioned *In-Situ*

Fishing effort by UK vessels is considered low (see Section 6.1) whilst the pipelines and umbilical are trenched to a top of pipe depth of around 1 m and rock covered in areas where a suitable depth was not acquired. In addition, following decommissioning activities independent verification of the seabed state will be obtained along the pipeline routes and evidence of clearance will be provided to all relevant governmental and non-governmental organisations.

Therefore, given the relatively low fishing effort, the depth of burial of the lines, and Lundin's requirement to provide evidence of clearance, any impacts on other sea users are not considered significant such that they are not discussed further.

7.2.3 Underwater Noise

Vessel traffic is considered the largest contributor to anthropogenic ocean noise with the primary sources of sound coming from the propellers, propulsion and other machinery (Ross, 1976; Wales and Heitmeyer, 2002). The potential impact of underwater noise on receptors depends on the actual level of noise received by the receptor and the receptor's sensitivity and response to that noise.

Richardson *et al*. (1995) reviewed the effects of vessel noise on marine mammals. They noted that it is not always possible to distinguish between effects due to the sound, sight or even smell of a vessel to an animal but there is evidence that noise from vessels has an impact on marine mammals. Animals have been reported to display a range of reactions from ignoring to avoiding the noise. The latter can lead to temporary displacement from an area. Vessel noise can mask communication calls between cetaceans, reducing their communication range (Jensen *et al*., 2009). Vessel noise may therefore impact on marine mammal behaviour, though it is not obvious from the literature whether these temporary behavioural reactions translate into long-term effects on an individual or population.

Fish have been observed to exhibit avoidance reactions to vessels and it is likely that radiated underwater noise is the cause (de Robertis and Handegard, 2013; Mitson and Knudsen, 2003). Reactions include diving, horizontal movement and changes in tilt angle (de Robertis and Handegard, 2013).

It is acknowledged that vessel noise may impact on marine mammal and fish behaviour. However, given the short offshore campaign and its location within a well-developed oil and gas area, in close proximity to the Haewene Brim FPSO, any impacts the additional vessel noise may have on marine mammals or fish are not considered significant such that they are not discussed further.

7.2.4 Discharges to Sea

Receptors that could be impacted by any discharges to sea include water quality, plankton, benthic species, fish and marine mammals.

Prior to contract award, Lundin will carry out a detailed assurance process on all vessels and only MARPOL compliant vessels will be use. Discharges from vessels will therefore be in line with MARPOL requirements such that the environmental impacts are not considered significant and therefore are not discussed further.

During the cutting operations there is the potential for small quantities of freshwater containing corrosion inhibitor (and possible residues of hydrocarbons) to be released from the production pipeline whilst small volumes of inhibited seawater may be released from the water injection pipeline. As discussed previously cutting of the umbilical ends will result in small volumes of methanol and a MEG/freshwater mix being released. However, given that the pipelines and umbilical are/will be flushed and cleaned and the chemicals added were selected on their environmental performance, the environmental impact of any discharges during pipeline decommissioning is considered low. Therefore, these potential discharges to sea are not discussed further.

7.2.5 Atmospheric Emissions

The principal emissions associated with the subsea activities will be the releases of combustion gases from the vessel engines. The assumed vessel requirements and anticipated fuel use for the proposed decommissioning activities are presented in Table 3-4 whilst Table 7-1 presents the anticipated emissions associated with this fuel use.

Table 7-1: Emissions Associated with Vessel Activity.

Activity	Total fuel use (te)	Te						
		CO_2	NOx	N_2O	SO_2	CO	CH_4	VOC
Decommissioning activities including post decommissioning surveys	1,249.5	3,998	74.22	0.27	5.0	19.62	0.22	2.50
Shipping emissions in UK waters (domestic and international) 2016*		14,500,000						
Vessel emissions as a % of shipping emissions in UK waters		0.027						
*Committee on Climate Change, 2017								

The maximum annual CO_2 emissions would comprise around 0.027 % of total UKCS domestic and international shipping emissions for 2016. The emissions associated with these operations may result in short-term deterioration of local air quality within the vicinity. However, in the exposed conditions that prevail offshore, these emissions are expected to disperse rapidly such that emissions from the vessels are not considered to have a significant environmental impact and therefore are not considered further.

It is acknowledged that there will be some emissions associated with the onshore transport and recycling of the recovered items, however given the small volumes of material to be recovered (see Section 8.2), the use of a permitted yard and landfill site, the impact from these emissions are not considered significant and therefore are not discussed further.

8. IMPACT ASSESSMENT

8.1 Seabed Disturbance

The decommissioning activities have been assessed as having the potential to impact the seabed in the following ways:

1. Mitigation of exposed pipeline and umbilical ends by cutting and removing or trenching and burying or rock dumping (see Section 4);
2. Removal of the five mattresses and the subsea infrastructure identified in Table 3-2;
3. Over trawl trials.

In order to assess the impacts of the proposed activities, the area of potential disturbance must be quantified. Table 8-1 assesses the seabed disturbance associated with the base case of cut and recover of the exposed pipeline ends whilst Table 8-2 assesses the disturbance associated with the worst case of rockdumping the exposed ends. In both scenarios both the temporarily and permanently disturbed areas are minimal.

For final DP approval, Lundin must provide evidence of clearance. This may be provided by either over trawl trials or alternative methods that do not impact on the seabed for example via a side scan sonar survey. If evidence of a clear seabed is required along the length of the pipeline routes Lundin will prioritise the use of non-intrusive survey methods to provide evidence of a clear seabed. However as a worst case whereby an overtrawl trial is carried out along the full length of the lines, impacting on a corridor width of 100 m along each trench, an area of up 2.4 km^2 (12 km (length of lines) X 100 m (width of trawl area) X 2 (two trenches) could be temporarily disturbed. Note: in line with Section 12.42 of OPRED Guidance Notes (BEIS, 2018) if trawl gear is not used to provide verification of a clear seabed, Lundin will discuss the selected alternative approach with OPRED.

Table 8-1: Area of Seabed Disturbance Associated with Base Case of Cut and Recover of Exposed Ends.

No.	Activity	Assumptions	Temporary disturbance (m^2)	Permanent Disturbance (m^2)
1	At the PLET location: Recovery of the PLET, the two PLET support frames, the two FJSSs, and the three GRP protection covers	Assumed area impacted by recovery of the PLET, support frames and FJSSs is within footprint of area disturbed by recovery of the protection covers. Therefore, area of disturbance assessed to be: 11 m (L) x 4 m (W) x 3 (number of covers)	132	-
2	At the PLET location: Relocation of rockdump associated with protection covers	Assumes worst case that dredging is required and rock is relocated across an area of 1 m extending either side of the protection covers. Total length of the three covers is 33 m (11 m x 3) and total width of the three covers is 12 m (4 m x 3).	-	90
3	At the Brynhild RBM location: Removal and wet store of the two GRP covers (in the immediate vicinity) to allow recovery of the Brynhild FJSS and subsequent reinstatement of the covers	Assumed area impacted by recovery of the FJSS is within footprint of area disturbed by recovery of the protection covers. Therefore, area of disturbance assessed to be: 11 m (L) x 7.6 m (W) x 2 (number of covers) – associated with wet store 11 m (L) x 7.6 m (W) x 2– associated with temporary disturbance of current location of the covers	334	-
4	At the Brynhild RBM location: Relocation of rockdump associated with protection covers	Assumes worst case that dredging is required and rock is relocated across an area of 1 m extending from the protection covers. Total length of the two covers is 22 m (11 m x 2) and total width of the two covers is 15.2 m (7.6 m x 2).	-	74.4
5	Recovery of the five mattresses on the water injection pipeline and the length of line that becomes exposed following mattress recovery	Assumed area impacted by recovery of the length of line recovered is within footprint of area impacted by recovery of the mattresses. Therefore, area of disturbance assessed to be: 6 m (L) x 3 m (W) x 5	90	-
6	Recovery of the section of production jumper and umbilical that become exposed on recovery of the protection covers	Assumed much of the area disturbed will overlap with area disturbed when carrying out activities 1 and 3 above. However as a worst case assumed no overlap and cut and recover activities impact on a corridor width of 1 m along length of lines (40.5 m of production jumper and 21.3 m of umbilical) to be recovered.	123	-
	Total		**679 m^2**	**164.4 m^2**

Table 8-2: Area of Seabed Disturbance Associated with Worst Case of Rock Dumping Exposed Ends.

Activity	Assumptions	Temporary disturbance (m^2)	Permanent Disturbance (m^2)
Impacts associated with Activities 1 and 3 in Table 8-1.	Disturbance as described in Table 8-1.	299	
Impacts associated with Activities 2 and 4 in Table 8-1.	Disturbance as described in Table 8-1.	-	164.4
Worst case assumption of rock dumping those sections of production jumper, umbilical and water injection line that become exposed when the protection covers are recovered.	Estimated that approximately 640 te would be required. As a worst case the EA assumes 1 te of rock cover impacts on $1m^2$ of seabed.	-	640
Total		**299 m^2**	**804.4 m^2**

8.1.1 Impact Assessment

The maximum area of seabed disturbance associated with the proposed decommissioning activities is 2.4 km^2. However, this relates to an area impacted by the over trawl trials and may be less if for example side scan sonar surveys are used to obtain evidence of clearance. In such an instance the maximum area of temporary disturbance is estimated to be around 0.0007 km^2. The impacts associated with the over trawl trials or the recovery activities (other than those associated with relocating the existing rockdump or addition of new rockdump to mitigate exposed ends) can be considered temporary because, following completion of activities, the seabed will begin to recover.

The seabed area considered to be permanently impacted is limited to the areas where rock cover is deposited. This includes the potential relocation of the existing rock associated with the GRP protection covers and as a worst case the use of rock to mitigate the exposed sections of pipelines and umbilical. As a worst case this is equivalent to an area of 0.0008 km^2.

During the recovery activities and over-trawl trials (if carried out), it is possible that disturbed sediment particles may be transported via tidal currents for re-settlement over adjacent seabed areas. Sessile epifaunal species may be particularly affected by increases in suspended sediment concentrations as a result of potential clogging or abrasion of sensitive feeding and respiratory apparatus (Nicholls *et al*., 2003). In the case of filter feeders, such as the juvenile *A. islandica*, an increased suspended sediment concentration could impact the ability to feed. Larger, more mobile animals, such as crabs and fish, are expected to be able to avoid any adverse suspended solid concentrations and areas of deposition. Evidence suggests that the sensitivity of fish to suspended sediments varies greatly between species and their life history stages and depends on sediment composition (particle size and angularity), concentration and the duration of exposure (Newcombe and Jensen, 1996). Being the major organ for respiration and osmoregulation, gills are directly exposed to, and affected by suspended solids in the water. If sediment particles are caught in or on the gills, gas exchange with the water may be reduced leading to oxygen deprivation (Essink 1999; Clarke and Wilber, 2000). This effect is greatest for juvenile fish as they have small easily clogged gills and higher oxygen demand (FeBEC 2010).

The ability for organisms to detect predators may also be reduced as a result of low visibility associated with suspended sediments. In instances of persistent and widespread suspended sediments there is the possibility of reduced feeding success among juvenile fish which may influence survival, year-class strength, recruitment and overall condition (Clarke and Wilber, 2000).

Any impacts from compression and sediment re-suspension are expected to be short lived since most of the smaller sedentary species associated with the area (such as polychaete worms) have short lifecycles and recruitment of new individuals from outside the disturbed area will be rapid. Recolonisation of the impacted areas can take place in a number of ways, including mobile species moving in from the edges of the area (immigration), juvenile recruitment from the plankton and burrowing species digging back to the surface. Recovery times for soft sediment faunal communities are difficult to predict, although some recent studies have attempted to quantify timescales. Collie *et al*. (2000) examined impacts on benthic communities from bottom towed fishing gear and concluded that, in general, sandy sediment communities were able to recover rapidly, although this was dependent upon the spatial scale of the impact. It was estimated that recovery from a small-scale impact, such as a fishing trawl, could occur within about 100 days assuming that recolonisation was through immigration into the disturbed area rather than from settlement or reproduction within the area. Recovery through immigration would be expected to take longer for the more extensive trawled areas, and larval recruitment or local reproduction by surviving individuals may be more important determining factors.

The placement of rock cover will result in the loss of habitat and smothering of the benthos. Conversely, it creates habitats for benthic organisms that live on hard substrates leading to an increase in local habitat and community diversity. Given the limited quantities or rock to be used in the worst case scenario of rock dumping the exposed line sections, and the fact that any rock that would be installed would be laid next to existing rock berms the environmental impact significance of any additional rock is considered low. In addition, given the evidence for rapid recovery following sediment resuspension and temporary seabed disturbance, any impacts from the recovery activities are also considered to be of low significance.

Transboundary and Cumulative Impacts

Apart from the overtrawl trial and post decommissioning surveys, all the activities described will take place within the Haewene Brim FPSO 500 m exclusion zone. Therefore, there are no anticipated transboundary impacts associated with remediating the exposed pipeline ends or removing the infrastructure discussed. Should an over trawl trial be carried out the length of the pipeline, it is possible that at the UK/Norwegian median line the trawl gear may encroach on the NCS whilst the vessel is turning, however any impact would be localised and within the scope of impact of fishing gear used in the area. As discussed previously, Lundin will consider alternative methods of acquiring evidence of a clear seabed that do not impact on the seabed for example via a side scan sonar survey. In this instance, there would be no transboundary impacts anticipated in relation to seabed disturbance.

With respect to cumulative impacts, the area is impacted by demersal trawl gear and the footprint associated with the proposed activities is considered minimal when compared to the impact associated with demersal trawl gear such that the cumulative impacts associated with the activities described are not considered significant.

8.2 Waste Management

Any material recovered to shore as part of the Brynhild Decommissioning Project is considered to be waste. The volume of material to be recovered is approximately 163 te (Table 8-3 and Section 3.8 of the DP). Any waste recovered will be treated in line with the Waste Hierarchy and it is estimated that a minimum of 33 % of recovered material will be recycled such that a maximum

of around 109 te will go to landfill. This percentage of recycled material assumes the mattresses are not recycled, however, Lundin will continue to try to identify a reuse for them. Should a reuse be identified the volume of waste to land fill would decrease by around 38% to 67 te. The percent of returned material to go to landfill is higher than seen in many decommissioning projects, however this is associated with the relatively larger percentage of plastic material in the recovered material. As with the mattresses, during the Contract and Procurement process, Lundin will continue to try to identify a reuse/recycle option for the structures.

Table 8-3: Material to be Recovered and Returned to Shore.

Activity	Planned weight to shore (te)	Total volume expected to be reused/recycled (te)	Total volume expected to go to landfill (te)
Subsea structures	113	49	64
Pipelines/umbilicals	8	5	3
Mattresses	42	0	42

The onshore environmental impacts from waste disposal are principally associated with landfills and can include:

- Use of sometimes scarce landfill space (resource use);
- Degradation of local/regional air quality as a result of onshore transport;
- Potential degradation of the water environment if any leachate is produced by the landfill site and reaches surface water and/or groundwater;
- Nuisance to the local community from traffic, odour and visual impacts.

Where materials are recycled, impacts will be associated with existing processing plants:

- Degradation of local/regional air quality as a result of transport;
- Degradation of local/regional air quality as a result of plant emissions;
- Degradation of the water environment (surface water and groundwater) associated with any discharges from the processing plant;
- Nuisance to the local community from traffic and visual impacts.

As part of Lundin's Duty of Care, contract award will be to an established yard with appropriate experience, capability, licences and consents in place. As part of this, the sites must demonstrate waste stream management throughout the deconstruction process.

The Brynhild Project will have in place a Waste Management Plan (WMP) developed to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes. Waste management options will take into account the waste hierarchy (http://wastehierarchy.wrap.org.uk/) shown in Figure 8-1 with a reduction in volume of waste being the preferred option.

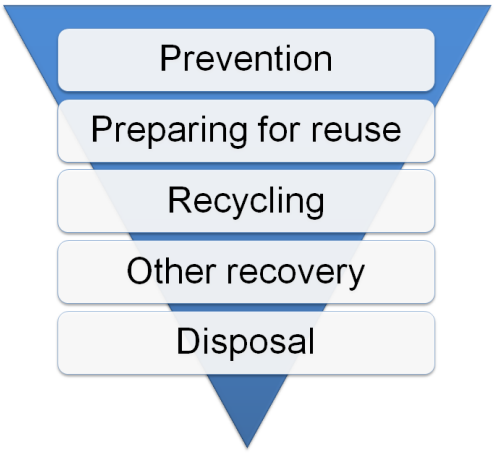


Figure 8-1: Waster Hierarchy.

Any NORM contaminated equipment will be handled, transported, stored, cleaned and recycled/disposed of in a controlled manner. Procedures will be in place to ensure that equipment is not released or handled without controls to protect the worker and prevent contamination of the environment.

Application of the above mitigation measures e.g. the use of permitted facilities (including landfill sites) and adherence to the waste hierarchy means the environmental and social impact significance is considered to be low.

Transboundary and Cumulative Impacts

The Brynhild Decommissioning Project's preference will be to avoid moving the recovered materials transboundary, however in the event the contract is awarded overseas Lundin will carry out assurance of the disposal yard and key sub contractor's disposal sites to ensure correct licences are in place such that any impacts out with the UK are not considered significant.

Similarly, any potential cumulative impacts of the waste management process are not considered significant as Lundin will, as part of the assurance process, ensure that disposal of the Brynhild materials will not breach any of the consents and permits in place.

8.3 Accidental Hydrocarbon Release

Of the accidental events identified in the ENVID Workshop only the total loss of diesel inventory from one of the vessels was considered to result in an environmental impact of moderate significance, whilst no scenario was identified to result in an impact of high significance.

To support the assessment of the environmental and socio-economic impacts of a loss of diesel inventory, modelling was undertaken using Oil Spill Contingency and Response (OSCAR) model developed by SINTEF (Stiftelsen for industriell og teknisk forskning - The Foundation for Scientific and Industrial Research). Details of how the model works can be found on the SINTEF website.

Stochastic and deterministic model runs were carried out. The stochastic modelling feature of OSCAR allows a single spill scenario to be run multiple times over different time periods (with different start and end times). This allows for the spill scenario to be modelled during different weather conditions. Results from all the individual stochastic simulations are then aggregated in order to report behaviour in a probabilistic or statistical sense.

Deterministic model runs are conducted for a single spill scenario over a specified meteorological interval. They are therefore used to highlight hydrocarbon behaviour over a specific time frame.

8.3.1 Hydrocarbon Thresholds Applied in the Model Run

The following thresholds have been adopted in the modelling:

- The model was run to determine the probability of a thickness of diesel at the surface of 0.3 µm. A surface thickness threshold of >0.3 µm is the minimum surface thickness identified by the Bonn Agreement Oil Appearance Code (BAOAC) capable of producing a visible rainbow surface sheen under good conditions. Whilst lower surface thicknesses may produce a visible sheen, this threshold value was chosen as that above which potential significant impacts on environmental sensitivities may begin to occur.
- A water column concentration threshold of 25 ppb was used to signify the level where potential impacts may start to be discernible. In context, 50 ppb is the lowest acute Predicted No Effect Concentration (PNEC) for any oil component in the OSCAR database, and is mid-range of the levels described as sub-lethal effects by Patin (2004).

Although not applied as thresholds in the model, the following threshold was used to guide the interpretation of the results:

- For sediment deposition, a mass of hydrocarbons of 50 mg per 1 kg of sediment (50 mg/kg) has been identified as the threshold above which toxic effects on benthic fauna may begin to be discernible. This threshold was adopted by OSPAR in the context of oil-based mud contamination of the seabed (OSPAR, 2009).

8.3.2 Modelled Scenario

Release parameters for the diesel spill scenario modelled are summarised in Table 8-4.

Table 8-4: Release parameter for the modelled spill scenario.

Description	Spill volume	Release location	Release duration	Release temp.
Release from a vessel working within the Haewene Brim 500 m exclusion zone	3,500 m^3	Sea Surface	1 hour	9.3 °C

8.3.3 Results

Stochastic modelling outputs show that the area where the probability of surface oil thickness and water column concentration exceeds the thickness (>0.3 µm) and concentration (>25 ppb) thresholds known to have a significant impact is limited (Figure 8-2). Moreover, the deterministic modelling, which illustrates a single oil spill scenario, shows that the area where these thresholds would be exceeded is further reduced (Figure 8-3).

Deposition in sediment was modelled as part of the deterministic modelling and the results indicate that only a limited area of the seabed will be affected by diesel deposition. Of the area impacted, a concentration greater than 50 mg/kg will not be exceeded with sediment concentrations not expected to exceed 1 mg/m^2 (Figure 8-4). In addition, the modelling predicted that there would be no beaching associated with such a spill.

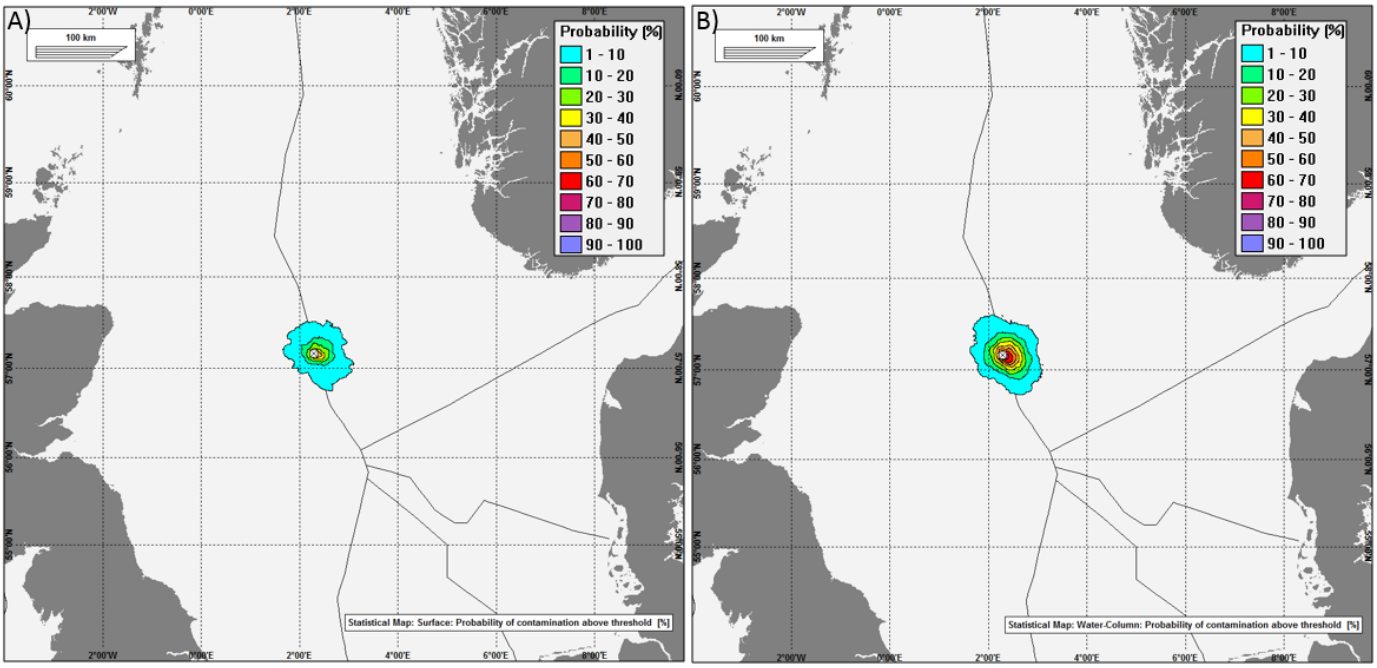


Figure 8-2: A) Probability of Surface Diesel Concentrations > 0.3 µm and B) Probability of Water Column Concentrations > 25 ppb.

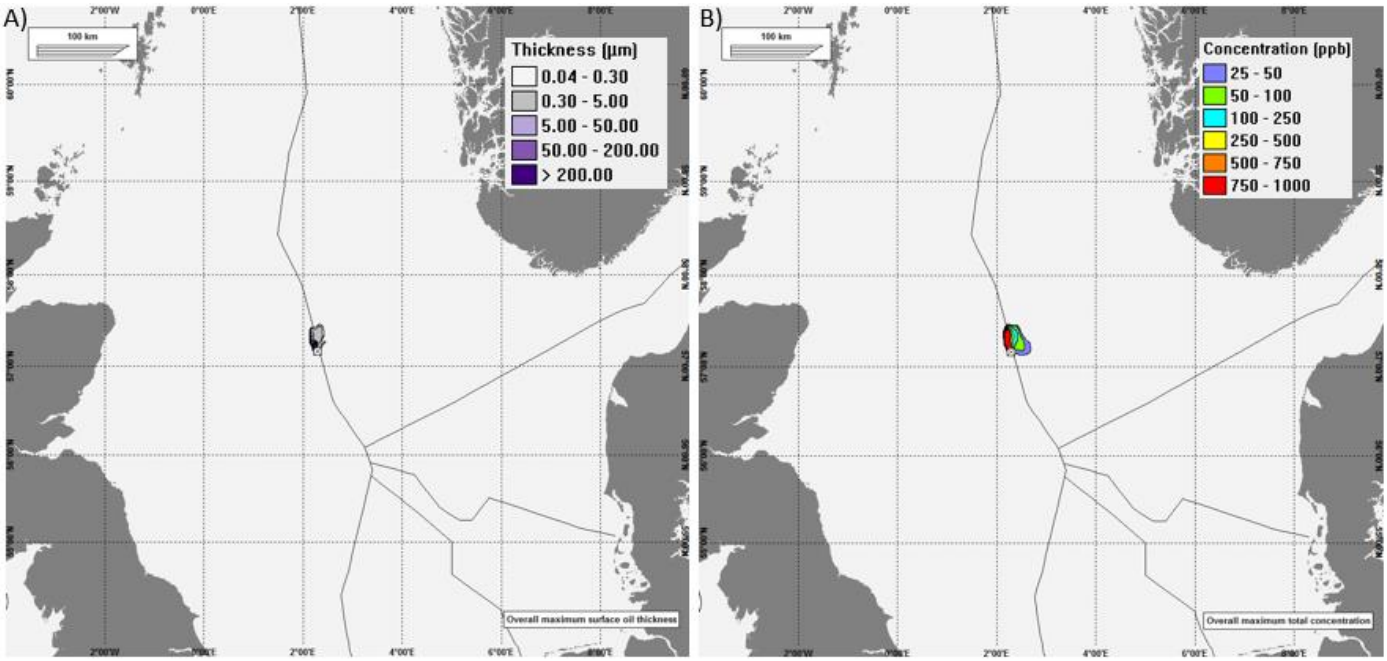


Figure 8-3: A) Maximum Surface Thickness and B) Maximum Total Water Column Concentrations.

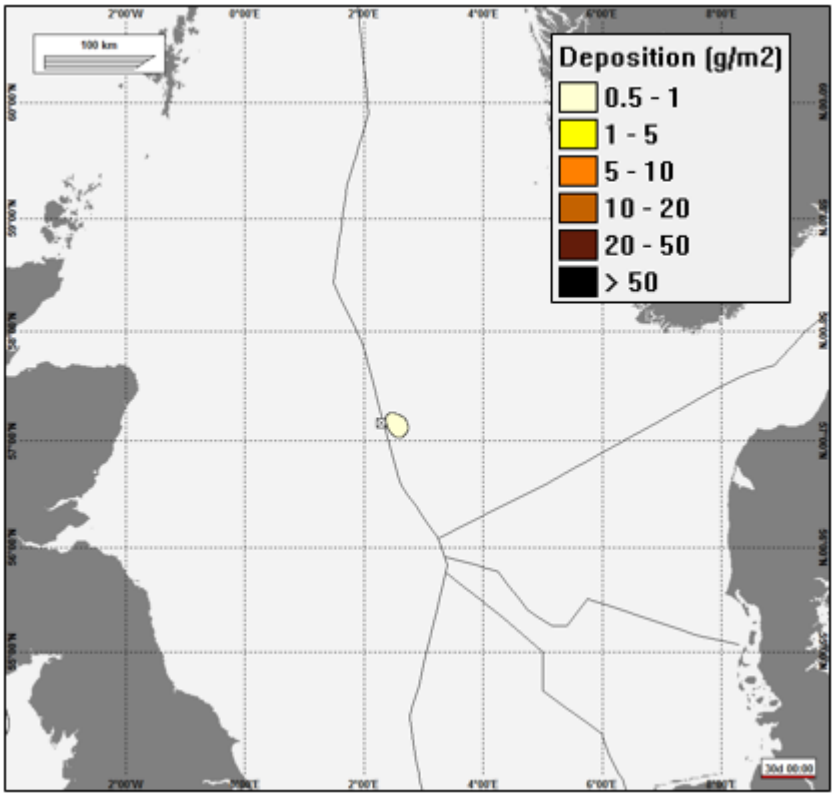


Figure 8-4: Maximum Sediment Concentrations.

8.3.4 Impact Assessment

Table 8-5 summarises the key environmental and socio-economic receptors in the area. Using the assessment methodology described in Appendix A (Section 11), a receptor sensitivity and magnitude of effect and subsequently an impact significance has been determined for each receptor in the event of a total loss of diesel inventory from a vessel. The impact significance is predicted to be either low or moderate depending on the receptor.

The likelihood of an accidental event resulting in a total loss of diesel inventory taking place is considered remote, such that combining the impact significance and the likelihood of a full diesel inventory release results in an environmental risk which is considered to be low (Table 8-6).

Table 8-5: Assessment of Environmental and Socio-Economic Impact

Receptor	Receptor sensitivity	Magnitude of effect	Impact significance
Plankton	Low	Minor	Low
Justification: similar to plankton community found over a wide area of the central North Sea.			
Benthos	Low	Minor	Low
Justification: diesel concentrations in the sediments will be > 50 kg/kg			
Fish	Medium	Serious	Moderate
Justification: spawning and nursery areas for a number of fish species are known to occur in the area (see Section 5.5.3). In addition, the spill would impact on a Norwegian PVA recognised as an important spawning area for mackerel. However, given the limited area of impact the magnitude of effect is considered serious rather than major.			
Fisheries	Medium	Minor	Low
Justification: review of the information collated by the Scottish Government suggests that fishing effort in the area is relatively low in comparison to the surrounding area. Vessels may be displaced from the impacted area for a short period (< 1 year) such that the magnitude of effect is considered minor rather than serious.			
Seabirds	Low	Major	Moderate
Based on the SOSI, the area impacted by the diesel release is considered to be of low sensitivity with regards to the impact of oil pollution on birds (see Section 5.5.5) In the event of a spill the diesel would evaporate from the surface over a matter of days, (generally less than 10 days), and would be present in discrete patches rather than covering the whole area indicated in the plots. Nevertheless because of relatively low exposure time needed to compromise a bird, the magnitude of effect is considered major.			
Marine mammals	Medium	Minor	Low
Harbour porpoise, white-beaked dolphin, minke whale, and and Atlantic white-sided dolphin have been sighted in the area. Marine mammals may be exposed to oil or diesel in one of two ways: • Internally (swallowing contaminated water, consuming prey containing oil based chemicals, or inhaling of volatile oil related compounds); and • Externally (swimming in oil or dispersants, or oil or dispersants on skin and body). There is little documented evidence of cetaceans being significantly affected by hydrocarbon spills. Therefore, given the limited extent of the area to be impacted, the magnitude of effect of a diesel release on marine mammals is considered minor.			
Designated areas/ coastal regions	Low	Negligible	Low
No designated areas expected to be impacted.			

Table 8-6: Summary of Environmental Risk.

Receptor	Impact significance	Likelihood	Environmental risk
Plankton	Low	Remote	Low
Benthos	Low		Low
Fish	Moderate		Low
Fisheries	Low		Low
Seabirds	Moderate		Low
Marine mammals	Low		Low
Designated areas/ coastal regions	Low		Low

Though the impact of a diesel release on fish and seabirds is considered to be moderate, taking the remote likelihood of a total loss of diesel inventory into account the environmental risk is considered low.

8.4 Assessment Against the Scottish NMP

Section 5.7 describes the Scottish NMP objectives to be achieved through the application of the 21 ‘General Planning Principles’. The activities assessed in this EA will not contradict the NMP objectives and as the project progresses Lundin will ensure they comply with the NMP policies.

9. CONCLUSION

The Brynhild Field is to be decommissioned by Lundin. In line with the results of a comparative assessment the pipelines and umbilical will be decommissioned *in situ* and the base case will be to cut and recover the exposed ends. The Brynhild structures and any exposed mattresses will be recovered.

9.1 Impact Assessment Results

The EIA process presented in this report considers the environmental and socio-economic impact significance of the planned and potentially unplanned activities associated with the decommissioning of the Brynhild Infrastructure within the UKCS. The impact significance was determined by considering the sensitivity of each receptor to the resultant aspect and the magnitude of the effect of each activity.

Receptors considered in the workshop included: air, water and sediment quality, plankton, benthic species, fish, marine mammals, seabirds, designated area, coastal communities, fisheries, shipping, landfill resources, resource use, local communities and cultural heritage. The impacts of emissions to air, discharges to sea, seabed disturbance, underwater noise, and waste production on each of these receptors was considered. In addition, the physical presence of the vessels during operations and the items to be decommissioned *in situ* were considered.

For all of the planned activities the environmental and social impacts were considered to be of low significance when standard industry mitigation measures were applied.

One accidental event was identified to have the potential to be a of moderate environmental significance: a loss of diesel due to vessel collision. When the impact significance and likelihood were taken into account, the environmental risk was considered to be low.

9.2 Summary of Mitigation Measures

Lundin will ensure routine environmental considerations are a key element of ongoing project decisions and assurance (e.g. vessels and yards) such that the environmental impact of the decommissioning activities will be minimised. Following the EIA process, it can be concluded that activities associated with the decommissioning of the Brynhild infrastructure located within the UKCS are unlikely to significantly impact the environment or other sea users, for example shipping traffic and fishing, provided that the proposed mitigation and control measures are put in place.

Table 9-1: Decommissioning of the Brynhild Field Infrastructure in the UKCS: Project Specific Commitments.

Aspect	Commitment
Physical presence	• Consultation with Scottish Fishermen's Federation (SFF); • Notice to mariners will be circulated; • Vessel use will be optimised • All vessels engaged in the project operations will have markings and lightings as per the International Regulations for the Prevention of Collisions at Sea (COLREGS) (International Maritime Organisation, 1972). • If used, rock cover will be optimised and carefully managed. A fall pipe will be used to ensure accuracy of the rock dumping. Size of rock cover will be in accordance with industry practice which is also the preferred SFF / industry best practices.

Aspect	Commitment
Atmospheric emissions and energy use	• As part of the tendering process, proposed vessels will go through a detailed assurance process which will include a review of generator and engine maintenance which leads to better efficiency in line with manufacturer's specifications. • Decommissioning vessel schedules will be planned to optimise (minimise) vessel use. • Prior to the contract award, Lundin will audit the decommissioning yards to ensure suitable permits are in place and that atmospheric emissions are being managed. • Activities will be carried out in line with Lundin's environmental policy which includes minimising emissions.
Discharges to sea	• Lundin will carry out a detailed assurance process on all vessels prior to contract award. • Work procedures will be in place to minimise offshore campaigns. • Only MARPOL compliant vessels will be used. • Flushing and cleaning of topsides and pipelines is completed in line with BAT/BEP requirements. • All contracted vessels will be signed up to the International Maritime Organization (IMO) and will adhere to their guidelines. • Any associated discharges will be managed to minimise impact.
Physical disturbance of the seabed and marine species	• Work procedures in place. • Use of rockdump will be minimised. • Priority will be given to the use of non-intrusive survey methods for determining a clear seabed.
Onshore activities	• Contract award will be to an established yard with appropriate experience, capability, licences, consents and community engagement in place.
Waste Management	• The Brynhild Project will have in place a Waste Management Plan developed to describe and quantify waste arising from decommissioning activities and identify available disposal options for those wastes. • Waste management options will take account of the waste hierarchy. • As part of Lundin's Duty of Care, contract award will be to an established yard with appropriate experience, capability, licences and consents in place.
Accidental events	• Any infrastructure decommissioned *in situ* will be marked on FishSafe and communicated accordingly. • Work procedures in place. • Use of trained personnel to carry out bunkering operations. • Vessel assurance inspections. • Emergency response plans in place including SOPEPs (shipboard oil pollution emergency plan). • SIMOPS (simultaneous operations) will be managed through bridging documents and communications.

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11. APPENDIX A: ASSESSMENT METHODOLOGY

This section presents the Environmental and Socio-Economic Impact Assessment (ESIA) and the Environmental and Socio-Economic Risk Assessment (ESRA) matrices used to determine the impact of the planned and accidental activities (respectively) associated with the project.

11.1 Receptors and Aspects

Prior to carrying out the ESIA / ESRA the potential receptors likely to be impacted were identified and the ways in which the activities may interact with the environment were ascertained.

11.1.1 Environmental and Socio-Economic Receptors

Receptors considered in the ESIA and ESRA include:

Environmental receptors:

- Air quality;
- Climate;
- Water quality;
- Sediment quality;
- Plankton;
- Benthic communities (including flora and fauna);
- Fish;
- Marine mammals;
- Seabirds;
- Designated areas;
- Landfill.

Social receptors:

- Resource availability (e.g. diesel, landfill sites etc.);
- Fisheries;
- Shipping.

11.1.2 Identification of Aspects

Aspects considered include:

- Energy use and emissions to air;
- Physical presence of vessels and drilling rig;
- Physical presence of infrastructure decommissioned *in situ;*
- Discharges to sea;
- Disturbance to the seabed (including disturbance to the cuttings piles);
- Underwater noise;
- Visual impacts;
- Waste generation;
- Resource use;
- Unplanned events; and

- Yard activities e.g. noise, odour etc.

The aspects associated with each activity were assessed in terms of their impact on the receptors in the area. For example, the use of vessels will result in emissions to air, discharges to sea, underwater noise, physical use of space and, if anchored, disturbance to the seabed. Receptors potentially impacted by these aspects include air quality, climate, marine mammals, seabirds, other users of the sea, seascape and benthic communities (if anchored).

11.2 ESIA for Planned Activities

The significance of the environmental/social impact of planned activities on each of the susceptible receptors was derived by considering the 'Receptor Sensitivity' in relation to the 'Magnitude of Effect' of the aspect.

11.2.1 Receptor Sensitivity

Four categories of Receptor Sensitivity were applied ranging from 'Low' to 'Very High' as shown in Table 11-1.

Table 11-1: Receptor Sensitivity.

Category	Environmental Definition
(a) Low	**Flora/Fauna/Habitats - within the impacted area** • Population sizes are considered to be of little to no geographical importance. • Species do not have designated conservation status and are of IUCN 'Least Concern'. • No designated habitat/sites. • Impacted species are widespread in the North East Atlantic region. **Air quality:** Emissions may impact on other nearby installations. **Water quality**: Open offshore water body. **Cultural heritage sites**: Site integrity is already compromised. **Resource availability:** (e.g. landfill sites, diesel use) Renewable and/or abundant. **Third party users:** have capacity to absorb change without impact.
(b) Medium	**Flora/Fauna/Habitats – within the impacted area** • Significant numbers of at least one receptor of national importance (e.g. PMFs). • Significant numbers of a species which is listed as IUCN 'Near Threatened'. • Nationally designated habitat/sites (e.g. PMFs). • Species may be of regional value. **Air quality**: Populated areas nearby. **Water quality**: Semi-enclosed water body with good flushing. **Cultural heritage sites:** Site is of local heritage importance. **Resource availability**: (e.g. landfill sites, diesel use) Renewable and/or available. **Third party users:** have capacity to absorb change without significant impact.

Category	Environmental Definition
(c) High	**Flora/Fauna/Habitats – within the impacted area** • Significant numbers of at least one receptor of regional (European) importance (e.g. Annex II / IV species and OSPAR designations). • Significant numbers of a species which are listed as IUCN 'Vulnerable'. • Regionally designated habitats/sites (e.g. OSPAR designations and Annex I habitats: SACs and SPAs). • Locally distinct sub-populations of some species may occur. **Air quality:** Densely populated areas nearby. **Water quality:** Semi-enclosed water body with limited flushing. **Cultural heritage sites:** Site is of regional heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Not renewable and/or limited availability. **Third party users:** have low capacity to absorb change and significant impact is likely to occur.
(d) Very High	**Flora/Fauna/Habitat – within the impacted area** • Significant numbers of at least one receptor of international importance. • Significant numbers of a species which are listed as IUCN 'Endangered' or 'Critically Endangered'. • Internationally designated habitats/sites (e.g. Ramsar sites). • At least one receptor is endemic (unique) to the area. **Air quality:** Very densely populated area with sensitive receptors such as schools and hospitals. **Water quality:** Enclosed water body with no flushing. **Cultural heritage sites:** Site is of international heritage importance. **Resource availability:** (e.g. landfill sites, diesel use) Not renewable and/or scarce availability. **Third party users:** have no capacity to absorb change e.g. unemployment due to long term closure of fisheries.

11.2.2 Climate Change

With respect to the emission of greenhouse gases, climate is considered a global receptor rather than a local receptor. The categories identified in Table 11-1 do not capture definitions for climate change. This is because the sensitivity status of climate is considered to be 'Very High' in line with the 2014 Climate Change Report produced by the Intergovernmental Panel on Climate Change (IPCC, 2014).

11.2.3 Magnitude of Effect

Definitions for the Magnitude of Effect on the receptors are presented in Table 11-2. Prior to determining the Magnitude of Effect, industry recognised 'base case' mitigation measures were assumed to be applied e.g. on mobilisation of vessels to carry out the work, other sea users will notify e.g. SFF.

Table 11-2: Magnitude of Effect.

Magnitude Level		Description	
		Environmental Impact	**Social Impact**
0	**Positive/No effect** *Regulatory compliance or Company goals are not a concern.*	**No environmental concerns** • Positive environmental impact e.g. retaining a 500 m zone resulting in a 'protected area'. • No significantly negative environmental effects.	**No public concerns** • Possible enhancement in the availability of a resource benefitting the persons utilising the area e.g. removal of 500 m zones results in return of access to fishing grounds. • No impacts on sites or features of cultural heritage. • No impact on resource or landfill availability.
1	**Negligible** *Regulatory compliance or Company goals are not breached.*	**Negligible environmental effects** • Any effects are unlikely to be discernible or measurable and will reverse naturally. • No beaching or transboundary impacts.	**Limited local public awareness and no concerns** • An intermittent short-term decrease in the availability of a resource which is unlikely to be noticed e.g. vessels working out-with existing 500 m exclusion zones could temporarily impact on a shipping route or fishing area. • Undiscernible changes to a site or feature of cultural heritage that do not affect key characteristics and are not above background changes. • Undiscernible use of a resource (e.g. diesel, rockcover or landfill).
2	**Minor** *Regulatory compliance is not breached.*	**Minor, localised, short term, reversible effect** • Any change to the receptor is considered low, would be barely detectable and at same scale as existing variability. • Recover naturally with no Company intervention required. • No beaching or transboundary impacts	**Some local public awareness and concern** • A temporary (<1 year) decrease in the availability or quality of a resource e.g. access to fishing grounds may temporarily be inhibited due to presence of vessels. • Minor changes to a site or feature of cultural heritage that do not affect key characteristics. • Minor use of a resource (e.g. diesel, rockcover or landfill).
3	**Serious** *Possible minor breach of regulatory compliance.*	**Detectable environmental effect within the project area** • Medium localised changes to the receptor are possible. • Localised Company response may be required. • No beaching or transboundary impacts.	**Regional / local concerns at the community or stakeholder level which could lead to complaints** • Medium decrease in the short-term (1-2 years) availability or quality of a resource affecting usage e.g. bring a rig on site for 1-2 years. • Nuisance impacts e.g. marine growth odour coming from yards. • Partial loss of a site or feature of cultural heritage. • Moderate use of a resource (e.g. diesel, rockcover or landfill).

Magnitude Level		Description	
		Environmental Impact	**Social Impact**
4	**Major effect** *Possible major breach of regulatory compliance.*	**Severe environmental damage extending beyond the project area** • High, widespread mid-term (2-5 years) degradation of the receptor. • Company response (with Corporate support) required to restore the environment. • Possible beaching and / or transboundary impacts.	**National stakeholder concerns leading to campaigns affecting the Company's reputation** • High mid-term (2-5 year) decrease in the availability or quality of a resource affecting usage e.g. closure of fishing grounds. • Substantial loss or damage to a site or feature of cultural heritage. • High use of a resource (e.g. diesel, rockcover or landfill).
5	**Critical effect** *Major breach of regulatory compliance resulting in project delays and prosecution.*	**Persistent severe environmental damage** • Very high, widespread long-term (>5 years) degradation to the receptor that cannot be readily rectified. • Major impact on the conservation objectives of internationally/nationally protected sites. • Full Corporate response required. • Major beaching and/or transboundary impacts.	**International public concern and media interest affecting the Company's reputation** • Very high decrease in availability of a resource and potentially livelihood of users for > 5 years e.g. *hydrocarbons on beaches affecting tourism or tainting of fish resulting in the long-term closure of fishing grounds.* • Total loss of a site or feature of cultural heritage. • Significant use of a resource (e.g. diesel, rock cover or landfill).

11.2.4 Environmental / Socio-Economic Impact Significance

The 'Receptor Sensitivity' and the 'Magnitude of Effect' were combined using the matrix presented in Table 11-3 to determine the level of impact for planned activities.

Table 11-3: ESIA matrix for planned activities.

		Receptor Sensitivity			
		(a) Low	(b) Medium	(c) High	(d) Very high
Magnitude of Effect	(0) Positive/No effect				
	(1) Negligible				
	(2) Minor				
	(3) Serious				
	(4) Major				
	(5) Critical				

(i) Positive / No effect significance	• Positive or no environmental or social impact. • No public interest or positive public support.
(ii) Low significance	• No/negligible environmental and social impact. • No concerns from consultees.
(iii)Moderate significance	• Discernible environmental and social impacts. • Requirement to identify project specific mitigation measures. • Concerns by consultees which can be adequately addressed by the Company.
(iv)High significance	• Substantial environmental and social impacts. • Serious concerns by consultees requiring Corporate support. • Alternative approaches should be identified.

11.3 ESRA for Unplanned Events

To determine the environmental and social risk of an unplanned event, firstly the significance of the environmental impact of an event should it occur was determined and secondly the likelihood of the event occurring.

11.3.1 Environmental and Social Significance of an Unplanned Event

The ESIA approach described in Section 11.2 for determining the environmental and social impacts of planned activities was also used to determine the significance of impacts that may result from unplanned events.

11.3.2 Likelihood of an Unplanned Event

Five categories of 'likelihood' have been identified as presented in Table 11-4.

Table 11-4: Likelihood of an unplanned event.

Likelihood Category	Definition
Extremely Remote	Has never occurred within industry or similar industry but theoretically possible.
Remote	Similar event has occurred elsewhere but unlikely to occur with current practices
Unlikely	Event has occurred in the industry during similar activities.
Possible	Event could occur during project activities.
Likely	Event is likely to occur more than once during the project.

11.3.3 Environmental Risk of an Unplanned Event

Combining the significance of the environmental/social impact with the 'likelihood of the unplanned event occurring' allows the level of environmental risk to be determined using the matrix presented in Table 11-5. Note the potential for a beneficial impact significance has been removed as it is not expected that an unplanned event would lead to a beneficial environmental or social impact.

Table 11-5: ESRA matrix for unplanned activities.

		Environmental significance of unplanned event*		
		(ii) Low	**(iii) Moderate**	**(iv) High**
Likelihood of event	**Extremely remote**	Low	Low	Low
	Remote	Low	Low	Medium
	Unlikely	Low	Medium	Medium
	Possible	Low	Medium	High
	Likely	Low	High	High

*Note the numbers associated with each significance level range from (ii) to (iv) in keeping with assignment in Table 11-3.

Low risk	• Negligible environmental and social risks. • Mitigation measures are industry standard and no project specific mitigation required. • No consultee concerns.
Medium risk	• Discernible environmental and social risks. • Consultee concerns can be adequately resolved. • Local public interest.
High risk	• Significant environmental and social risks. • Serious consultee concerns. • Media interest and reputational impacts.

12. APPENDIX B: ENVID RESULTS

ENVID Results

Activity	Aspect	Receptors																	Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Environmental Risk (unplanned event)
		Environmental											Societal											
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage							
Vessel Use																								
Vessel use	Emissions to air		a																Fuel combustion emissions (CO_2, CO, SOx, NOx, etc.) from vessels including excavator vessel, reverse reel lay vessel and survey vessels. UK and EU Air Quality Standards not exceeded.	Minimise use of vessels through efficient journey planning and use of relevant vessels for each activity. All vessels will be MARPOL compliant.	2	L	N/A	N/A
	Physical presence								b	a			a	a					Potential impact on multiple users especially commercial fisheries e.g. through collision with towed fishing gear.	Minimise use of vessels, through efficient journey planning. Notify other sea users e.g. Kingfisher, Scottish Fishermen's Association (SFF) etc. Ongoing collaboration with SFF as required. Navigational aids including radar, lighting and Automatic Identification Systems (AIS) will be used. A vessel Collision Risk Assessment (CRA) will be produced if required.	1	L	N/A	N/A
	Discharges to sea: vessel sewage			a		a		b	b										Discharge of sewage; grey and black water macerated to <6 mm prior to discharge and discharge of food waste to sea. Organic enrichment and chemical contaminant effects in water column and seabed sediments.	Minimise use of vessels, through efficient journey planning. All vessels will be MARPOL compliant. In line with MARPOL regulations there will be no discharge of treated sewage within 3 nautical miles (nm) of land.	1	L	N/A	N/A
	Discharges to sea: ballast water			a		a	b	b	b										Water quality in immediate vicinity of discharge may be reduced, but effects are usually minimised by rapid dilution in receiving body of water and non-continuous discharge. Possible introduction of invasive species depending on vessel routes.	Lundin audit procedures will ensure that the contracted vessels ballasting procedures are in line with the International Maritime Organisation (IMO) Convention aimed at preventing associated harmful effects. All discharges monitored and records maintained.	1	L	N/A	N/A

Activity	Aspect	Receptors																	Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Environmental Risk (unplanned event)
		Environmental											Societal											
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage							
	Discharges to sea: biofouling					a	b	b											Bioinvasions as a result of biofouling (accumulation of organisms including plants, algae, or animals such as barnacles) on vessels.	Contracts will be awarded to contractors originating from countries signed up to IMO. As part of Lundin's auditing process, only vessels adhering to the IMO 2011 2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Species will be used. All member states of IMO are signed up to these Guidelines.	2	L	N/A	N/A
	Underwater noise							b	b										Vessels will use Dynamic Positioning (DP) and will have the potential to cause disturbance to marine mammals and fish in the form of temporary displacement from the area. Marine mammals and fish are expected to return once the vessel(s) has left the area.	Minimise use of vessels, through efficient journey planning.	2	L	N/A	N/A
	Waste														b				General vessel waste.	Lundin will ensure vessels are compliant with MARPOL and flag state requirements and have a Waste Management Plan (WMP) in place.	1	L	N/A	N/A
	Resource use	a																	Fuel use.	Minimise use of vessels, through efficient journey planning.	1	L	N/A	N/A
	Unplanned event: loss of vessel fuel inventory			a	a	a	a	b	c	c		c	b	a	b				Unforeseen event during operations for example a collision or fire resulting in a loss of fuel inventory Reel-lay vessel *c*. 5,500 m^3 of fuel Light weight intervention vessel c. 2,500 m^3 Modelling of a diesel release (3,000 m^3) in the area of the Haewene Brim FPSO suggests that area of impact is minimal.	Emergency response plans in place including vessel SOPEPs. SIMOPs will be managed through bridging documents and communications.	2	M	R	L

Activity	Aspect	Receptors																	Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Environmental Risk (unplanned event)
		Environmental											Societal											
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage							
Offshore Activites Associated with Decommissioning of Pipelines and Umbilical																								
Cut and recover of exposed pipeline and umbilical ends. Majority of the length of pipelines and umbilical decommissioned in situ.	Physical presence of main pipeline and umbilical lengths following recovered of exposed ends						b						b						There are no mid-line exposures on the lines. Low potential for additional exposures to occur. Pipeline status reports have found seabed to be stable over all trenched and buried pipelines and umbilical.	Post decommissioning pipeline status surveys to be carried out.	2	L	N/A	N/A
	Discharges to sea: flushing fluids			a		a	b	b	b			c							Discharge of fluids at cut ends: -inhibited seawater from water injection pipeline; -freshwater with oxygen scavenger and residual oil from the production pipelines; -Umbilical cores at time of decommissioning will contail methanol (one core) and MEG/freshwater mix (six cores). Only at pipeline ends as no cutting of mid line exposed sections.	Production pipeline has been flushed three times and is expected to only contain residual volumes of oil. Comply with relevant regulations such that the use and/or discharge of all chemicals has been/will be subject to risk assessment and permitting under PETS.	1	L	N/A	N/A
	Discharges to sea: following pipeline degradation				b		b	b											Following pipeline degradation, content of lines will be release to seabed. Pipelines will be buried under sediment or rockdump *c* . 0.6m deep, therefore any residual contents in the lines are not expected to become exposed to the seabed surface. Unlikely to be measurable in sediment, benthic communities or fish. Note: when operational the Brynhild pipeline was operated above the Wax Appearance Temperature (30^{o}C) for the entire flowing period and as such only negligible amounts of wax are expected to be present in the pipeline.	Majority of the pipeline will be buried under sediment or rockdump *c* . 0.6m deep.	1	L	N/A	N/A
	Disturbance to the seabed during cuttings operations						a	b					b						Localised jetting to access pipeline for cutting activities. Assume potential for use of baskets for ROV work as a worst case. Grapple may be used.	Existing rock cover will be extended to cover ends.	1	L	N/A	N/A
Trenching and burying of exposed ends (should the cut and recover option be deemed not viable following Contracting and Procurement Engagement exercise).	Disturbance to the seabed						a	b					b						Some resettlement of sediments during trenching and burying activities. Additional material other than that displaced would be required.	Over trawlability survey carried out following operations.	1	L	N/A	N/A

Activity	Aspect	Receptors																	Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Environmental Risk (unplanned event)
		Environmental											Societal											
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage							
Rock cover of exposed ends (should the cut and recover or trench and bury options be deemed not viable following Contracting and Procurement Engagement exercise).	Physical presence of rock: social receptors												b						Impact on fishing gear.	Any rock to be laid will be placed along existing rock profiles. Quantity of rock cover will be optimised and consultation will be carried out with SFF regarding rock cover profile. Over-trawlability survey.	1	L	N/A	N/A
	Physical presence: environmental receptors (change in habitat type, impact on benthic animals).				a		b												Laying rock along existing profiles	Minimise quantities of rock to be laid.	1	L	N/A	
	Resource use	b																	Use of rock. Around 174 te of rock would be required should this option be chosen to remediate ends of all lines.		1	L	N/A	N/A
Offshore Activites Associated with Decommissioning of Remaining Infrastructure																								
Lifting of mattresses, pipeline end manifold, flexible jumper support structures, glass reinforced plastic protection covers.	Disturbance to the seabed						b	b											If not possible to recover the five exposed mattresses using traditional methods, items will be cut up/broken up and removed using divers which could require multiple basket laydowns. Some minimal sedimentation impacts. Disturbance to existing rock on the glass reinforced plastic structures. Increase in suspended solids in the water column.	A lifting plan will be in place which will minimise the likelihood of dropped objects.	1	L	N/A	N/A
Unplanned event	Dropped object						a												Potential of a significant dropped object during operations (e.g. a container) Potential drop on live Pierce production line - SIMOPS	Approved work procedures in place. Experienced contractors will be used. These work procedures will ensure lifting of items is not done over the Pierce production pipeline i.e. deployments and recovery operations done in safe working zone PON2 reporting for dropped object into the sea. Expected that any dropped objects would be recovered. Debris survey will be carried out.	1	L	R	L

Activity	Aspect	Receptors																	Observations	Existing mitigation	Magnitude of effect	Impact Significance	Likelihood (unplanned event)	Environmental Risk (unplanned event)
		Environmental											Societal											
		Resource availability	Air quality	Water quality	Sediment Quality	Plankton	Benthic communities	Fish	Marine mammals	Seabirds	Coastal marine communities	Designated areas	Fisheries	Shipping	Landfill resources	Local communities	Cultural heritage							
Onshore activities																								
Onshore activities associated with the decommissioning project.	Emissions to air		b																Fuel combustion emissions (CO_2, CO, SOx, NOx, etc.) from lorries and cuttings tools and recycling operations.	Use existing yard with EIA previously completed. Yards EIA will be main control. Lundin to audit yard: pre-selection and pre-use audits.	1	L	N/A	N/A
	Noise and vibration															a			Lorries transporting the recovered infrastructure.		1	L	N/A	N/A
	Odour	N/A																						
	Waste														b				Any component parts that cannot be reused or recycled will go to landfill.	All waste will be handled and disposed of in line with regulations which will be detailed in the WMP. Waste management will follow the waste hierarchy: reduce, reuse, recycle. Lundin to audit the landfill site.	1	L	N/A	N/A
	Hazardous waste														b				For example, NORM on recovered infrastructure.	A radiation protection supervisor will be on board the vessels to determine if there is NORM on any of the oil pipelines being recovered. If detected on recovered infrastructure, where possible the NORM will be discharged to sea under the existing permit, thus reducing volumes returned to shore. If returned to shore it will be transported and disposed of in line with the relevant regulations which will be detailed in the WMP. A permitted disposal site will be selected.	1	L	N/A	N/A