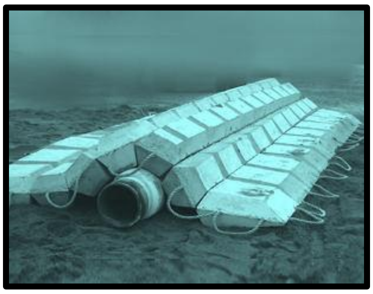
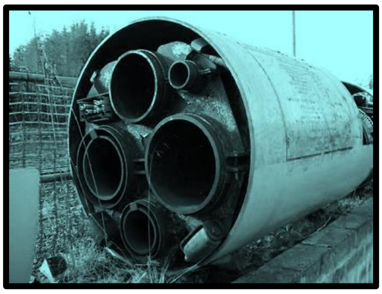
Leadon Decommissioning

Environmental Statement

Final V2

March 2015

Table of Contents

MAERSK

ABBREVIATIONS, ACRONYMS AND UNITS

	Definition
%	Percentage
˚C	Degrees Celsius
µg/g	Micrograms per gram
µg/g	Micrograms per kilogram
$\mu g/m^3$	Micrograms per cubic metre
µm	Micrometres
µPa	Micropascal – The SI derived unit of pressure
Ba	Barium
$BaSO_4$	Barite
BAT	Best Available Technique
BEP	Best Environmental Practice
BMS	Business Management System
BOD	Biological Oxygen Demand
BSI	British Standards Institute
CA	Comparative Assessment
Cd	Cadmium
CEFAS	Centre for Environment, Fisheries & Aquaculture Science
CFC	Chlorofluorocarbon
CH_4	Methane
Chl a	Chlorophyll a
CITES	Convention on International Trade in Endangered Species of wild fauna and flora
Cr	Chromium
cSAC	Candidate Special Area of Conservation
CSV	Construction Support Vessel
CO	Carbon monoxide
CO_2	Carbon dioxide
COND	Condensate
Cu	Copper
dB	Decibel – The logarithmic measure of sound/ pressure
DECC	The Department of Energy and Climate Change
DEFRA	Department of Environment, Food and Rural Affairs
DP	Dynamic Positioning
DSV	Diving Support Vessel
DTI	Department of Trade and Industry
EA	Environmental Assessment
EC	European Commission
EIA	Environmental Impact Assessment
EMS	Environmental Management System
EPS	European Protected Species
ES	Environmental Statement
EU	European Union

EU ETS	European Union Emissions Trading Scheme
EUNIS	European Union Nature Information System
FEED	Front End Engineering Design
FEPA	Food and Environment Protection Act
FPSO	Floating Production Storage and Offloading
FSU	Floating Storage Unit
g/cm^3	Grams per cubic centimetre
GJ	Gigajoule
GMS	Global Marine System Ltd
HASS	High Activity Sealed Source
HCV	Heavy Construction Vessel
HCFC	Hydrochlorofluorocarbon
Hg	Mercury
HR	Habitats Regulations
Hz	Hertz – The SI unit of the frequency
HSE	Health, Safety and Environment
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organisation
IoP	Institute of Petroleum
IOPP	International Oil Pollution Prevention
IPPC	Integrated Pollution Prevention and Control
ISO	International Organisation for Standardisation
ISO 14001	International Organisation for Standardisation environmental management system
JNCC	Joint Nature Conservation Committee
kg	Kilograms
kHz	Kilohertz
km	Kilometres
km^2	Square kilometres
Knot	Unit of speed equal to one nautical mile (1852 m) per hour
Kpa	Kilopascal
kW days	A measurement of fishing effort: (engine power x days at sea)
LAT	Lowest Astronomical Tide
LCP	Large Combustion Plant
LDPE	Low Density Polyethylene
LSA	Low Specific Activity
m	Metre
m^2	Square metre
m^3	Cubic metre
mg/l	Milligrams per litre
MARPOL	International Convention for the Prevention of Pollution for Ships (Maritime Pollution Convention)
MCA	Maritime and Coastguard Agency
MCAA	Marine and Coastal Access Act
MDAC	Methane-Derived Authigenic Carbonate
MEG	Monoethylene Glycol

MLS	Mid Line Structure
mm	millimetre
MPA	Marine Protected Area
MS	Management System
m/s	Metres per second
MW	Megawatt
N_2O	Nitrous Oxide
n-alkane	Higher (straight chain) alkane
NBR	Northern Bundle Replacement
ND	Not Detected
NER	New Entrants Reserve
Ni	Nickel
NFFO	National Federation of Fishermen's Organisations
NIFPO	Northern Ireland Fish Producers' Organisation
nmiles/ nm	Nautical Miles – Unit of length equivalent to 1,852 metres
NNR	National Nature Reserve
NORBRIT	Norwegian/British Agreement
NORM	Naturally Occurring Radioactive Material
NOx	Oxides of Nitrogen
NO_2	Nitrogen Dioxide
NRC	National Research Council
NSA	National Scenic Area
NSTF	North Sea Task Force
NTS	Non-Technical Summary
OBF	Oil Based fluid
OBM	Oil Based Mud
OCN	Offshore Chemical Notification
ODS	Ozone Depleting Substances
OGP	International Oil and Gas Producers Association
OGUK	Oil and Gas UK
OHSAS	Occupational Health and Safety Assessment Series
OMCR	The Offshore Marine Conservation (Natural Habitats, & c.) Regulations 2007
OMR	Offshore Marine Regulations
OPEP	Oil Pollution Emergency Plan
OPF	Organic Phase Fluid
OPPC	Oil Pollution Prevention and Control
OPRC	Oil Pollution Preparedness Response and Co-operation
OSIS	Oil Spill Information System model
OSPAR	Oslo Paris Convention – The OSPAR Convention guides international cooperation on the protection of the marine environment of the North-East Atlantic
OSR	Oil Spill Response
OVI	Offshore Vulnerability Index
Pb	Lead
PCB	Polychlorinated Biphenyl
PDI	Project Development International Limited

PAH	Polycyclic Aromatic Hydrocarbon
PEC:PNEC	Predicted Environmental Concentration : Predicted No-Effect Concentration
PON1	Petroleum Operations Notice covering accidental offshore oil and chemical releases
PPC	Pollution Prevention and Control
PPD	Public Participation Directive
ppm	Parts per million
ppt	Parts per thousand
PSV	Platform Support Vessel
pSAC	Possible Special Area of Conservation
PTS	Permanent Threshold Shift – A permanent elevation of the hearing threshold resulting from physical damage to the sensory hair cells of the ear
REACH	Registration Evaluation Authorisation and Restriction of Chemicals
ROV	Remotely Operated Vehicle
RQ	Risk Quotient
RSPB	Royal Society for the Protection of Birds
RSV	ROV Support Vessel
SAC	Special Areas of Conservation
SAST	Seabirds At Sea Team
SBF	Synthetic Based Fluid
SCANS	Small Cetacean Abundance in the North Sea and Adjacent waters
SCI	Sites of Community Importance
SD	Standard Deviation – Variation around a mean value in a dataset
SEA	Strategic Environmental Assessment
SFF	Scottish Fishermen's Federation
SGMD	Scottish Government Marine Directorate
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SOPEP	Shipboard Oil Pollution Emergency Plan
SOSREP	Secretary of State for Energy and Climate Change
SOx	Oxides of Sulphur
SO_2	Sulphur Dioxide
SPA	Special Protection Area
SPL	Sound Pressure Level – the decibel ratio of sound pressure to some reference pressure in dB re 1μPa in underwater acoustics (zero-to-peak)
SWT	Scottish Wildlife Trust
SSIV	Subsea Isolation Valve
SSSI	Site of Special Scientific Interest
T/Te	Tonnes
THC	Total Hydrocarbons
TROS 650	O_2 scavenger, biocide and corrosion inhibitor mixture
TTS	Temporary Threshold Shift – Temporal and reversible elevation of the auditory threshold which is the minimum sound level that can be perceived by an animal in the absence of background noise
UK	United Kingdom
UKBAP	UK Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf

UKDMAP	United Kingdom Digital Atlas Marine Project
UKOOA	United Kingdom Offshore Operators Association
UKOPP	UK Oil Prevention Pollution
UNCLOS	United Nations Convention on the Law Of the Sea
UNECE	United Nations Economic Commission for Europe
UTM	Universal Transverse Mercator (coordinate system)
V	Vanadium
VOC	Volatile Organic Chemical
WEEE	Waste Electrical and Electronic Equipment
WFD	Water Framework Directive
WMP	Waste Management Plan
WMS	Waste Management Strategy
Zn	Zinc

0.0 NON-TECHNICAL SUMMARY

This non-technical summary outlines the findings of the Environmental Impact Assessment (EIA) conducted by Maersk Oil (Maersk) as part of the planning and consents process for the decommissioning of the Leadon Field. The purpose of the EIA is to identify, understand and communicate the likely significance of the environmental impacts and risks associated with the proposed project, to inform the decision making process. The EIA also addresses any concerns or issues raised by stakeholders during the consultation process. A detailed assessment is presented within this Environmental Statement (ES).

The Maersk operated Leadon Field is currently being considered for decommissioning. The field is situated in block 9/14 of the northern North Sea approximately 306 km northeast of Aberdeen (Figure i).The Leadon facilities were installed in 2001 and consist of two drill centres (North Drill Centre and South Drill Centre) connected by two pipeline bundle sections, which are in turn connected by a mid-line structure. A gas import flowline connects the Leadon Mid-line Structure (MLS) with Beryl Alpha (Figure i). The field was produced via the Global Producer III Floating Production, Storage and Offloading (FPSO) platform moored at the MLS location. Production was suspended in July 2006 and cessation of production granted the same year. The FPSO and mooring system were removed in 2006 and the risers were recovered in 2007.

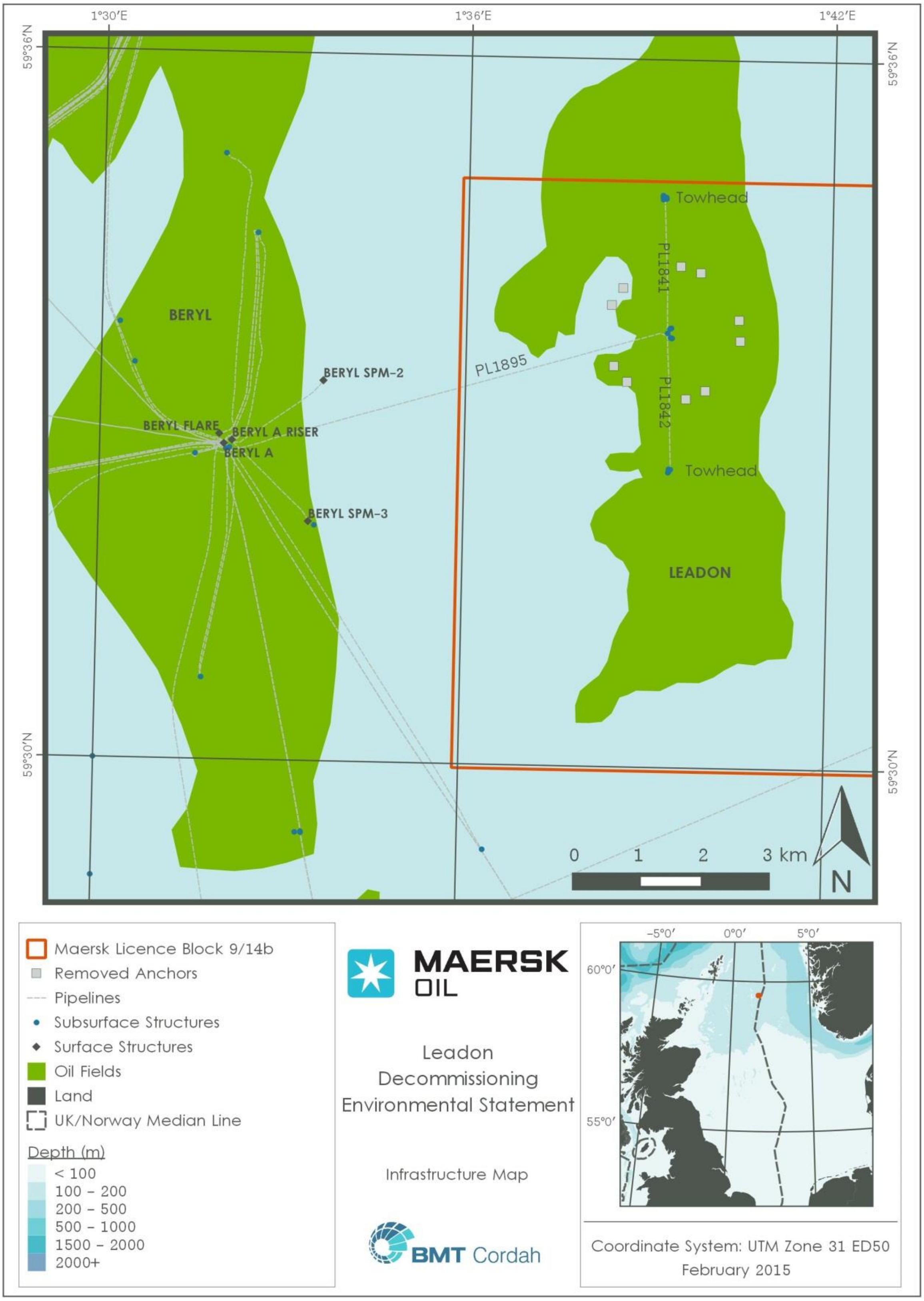
Regulatory Context

The decommissioning of offshore oil and gas infrastructure in the UKCS is principally governed by the Petroleum Act 1998, as amended by the Energy Act 2008, which sets out the requirements for a formal Decommissioning Programme and the approval process. Under the Department of Energy and Climate Change (DECC) Guidance Notes on Decommissioning of Offshore Oil and Gas Installations and Pipelines, the Decommissioning Programme must be supported by an EIA.

The DECC Guidance Notes state that an EIA should include an assessment of:

- all potential impacts on the marine environment including exposure of biota to contaminants, biological impacts arising from physical effects, and conflicts with the conservation of species and their habitats;
- potential impacts on environmental compartments, including emissions to the atmosphere, discharges to water, leaching to groundwater and effects on the soil;
- consumption of natural resources and energy associated with re-use and recycling;
- interference with other legitimate uses of the sea and other consequential effects on the physical environment; and
- potential impacts on amenities, the activities of communities and on future uses of the environment.

In addition under the Marine and Coastal Access Act 2009 and the Marine (Scotland) Act 2010 a licence application will be required at the time of decommissioning and the supporting EIA/ ES updated to reflect detailed engineering design and specific mitigation measures.



Sources: DECC, 2013a; UK Oil and Gas Data, 2014.

Figure i: Location of the Leadon Field and associated facilities.

The Petroleum Act 1998 provides the framework for the orderly decommissioning of offshore pipelines. The 'DECC Guidance Notes' requires that all feasible pipeline decommissioning options should be considered and a comparative assessment made.

Overview of the Leadon Decommissioning Programme

The decommissioning programme will encompass the following subsea infrastructure:

- structures including wellheads, towheads, the MLS and riser bases;
- ancillary materials i.e. concrete mattresses, grout bags;
- individual surface laid flowlines and connectors; and
- pipeline bundle comprising two sections: the 2.1 km long, 42.5" (1.08 m) diameter, 1,903 tonne north section and the 2.1 km long, 47.5" (1.21) diameter, 2350 tonne, south section. Internally, the bundle sections carry various flowlines and control systems that bring services and production to and from the wells.

All subsea structures, ancillary materials and individual laid flowlines/ connectors in the field will be completely removed and recovered onshore for recycling and/ or disposal. Based on the outcomes of an initial Comparative Assessment (CA), it was decided that the best option for the removal of structures (including the wellheads, towheads, MLS and spoolpieces) was to cut and recover. Reverse reel was the preferred option for recovery of the gas flowline. In line with DECC Guidance all concrete mattresses that are not reusable on site will be recovered from the seabed for disposal onshore.

After analysis of the drilling data it was concluded that the Leadon Field did not require full Stage 1 screening owing to the spacing between the well sites and the minimal use of Oil Based Mud (OBM). For Leadon the environmental assessment was made on the basis that no further decommissioning actions will be required for the drill cuttings in the Leadon Field.

Following the initial CA and during consultation with DECC, it was decided the recommended decommissioning options for bundle decommissioning required further assessment under a second CA. The options included:

• **Leave in place**	**Burial in current location**	**or**	**Move to a pre-cut trench**
• **Remove**	**Lift and tow to shore**		

The assessment indicated that the "leave in place" options were rated highest under eleven of the criteria assessed (including safety), compared to "full removal," which was judged as the best option under six of the criteria. Of the options to trench or bury the bundle, burial was the preferred option under seven of eight criteria.

Based on the outcome of the CA process, this ES focuses on the impact to the environment for the burial option via rock dump. Whilst the initial decommissioning strategy may entail a partial rock dump option (rock dumping the exposed bundle terminus ends and MLS ends), this ES will consider the strategy with the greatest environmental footprint, namely the rock dump of the entire length of the two bundle sections.

Surveys will be carried out where infrastructure has been removed and a carefully designed monitoring regime will be implemented to ensure that the Leadon infrastructure that is decommissioned in place is maintained in a safe condition.

Environmental Setting and Sensitivities

The Leadon Field is located in a water depth of approximately 120 m, in an area that is typical of the offshore regions of the northern North Sea, where hydrographical, meteorological, geological and biological characteristics are relatively uniform over large areas. Users of the area are mainly associated with oil and gas exploration and development, shipping and fishing. Table i highlights the key physical, chemical, biological and socioeconomic sensitivities relevant to the Leadon area.

Table i: Key Environmental Sensitivities

Potential sensitivity	Relevance to Leadon area
Habitats Directive: Annex I Habitats	No Annex I habitats have been observed in the immediate vicinity of the bundle locations during ROV surveys.
Habitats Directive: Annex II Species	Harbour porpoise present in very high numbers in February, high in July and September, medium numbers in August and low numbers in December, January, April, May and June.
Benthic Fauna	Characteristic of northern North Sea.
Plankton	Characteristic of northern North Sea with peak production in spring and summer
Finfish and Shellfish	The Leadon Field lies within an area of high spawning intensity for Norway Pout (March to May) and a high nursery intensity nursery area for Blue whiting. The site sits in low intensity areas of spawning activity for cod (January to April), whiting (February to June), mackerel (May to August), and sandeels and a low intensity nursery area for whiting, mackerel, sandeel, herring, anglerfish, and hake. The site is in an area of undetermined spawning intensity for haddock (February to May) and saithe (January to April)
Marine Mammals	Marine mammals sighted in and around the Leadon area include minke whales, killer whales, white-beaked dolphins, white-sided dolphins and harbour porpoises. Peak sightings occur in summer months.
Seabirds	Seabird vulnerability to oil pollution in the Leadon area is “very high” in October, “high” in January, July, and November and “moderate” to “low” for the rest of the year. Overall vulnerability in the Leadon area is “moderate”.
Fisheries	Overall, the relative fisheries value of ICES rectangle 48F1 in 2013 was considered to be moderate for demersal species and low for pelagic and shellfish species
Shipping	Shipping traffic in the vicinity of Leadon Field is of very low density, with less than two vessels per day.
Oil and Gas Infrastructure	The Leadon infrastructure lies in an area of high oil and gas activity. The 4” gas import flowline (PL1895) ties into the MLS at Leadon and runs to a valve structure within the Apache operated Beryl Alpha Platform 500 m zone, 7.5 km to the west of Leadon. The flexible flowline crosses a number of pipelines in the Beryl Alpha 500 m zone.
Other Users of the Sea	In the immediate vicinity of the Leadon infrastructure there are no recorded wrecks (SeaZone, 2014). Blocks 9/13 and 9/14 do not lie within a designated military exercise area.

Key Environmental Concerns

Interactions between the proposed decommissioning activities and the local environment were assessed though a risk assessment process and a stakeholder consultation. The following key environmental impacts were identified as requiring further assessment.

Disturbance to the seabed

Decommissioning operations at the Leadon Field will result in work being undertaken at or near the seabed. Therefore, there is the potential for short-term localised seabed disturbance during the recovery of surface-laid structures, and for the long-term modification of the seabed as a result of the placement of protective rock dump during burial of the bundle.

Localised disturbance will affect a relatively small seabed area (estimated at 0.004 km^2) and occur mainly from the manoeuvring of the remotely operated vehicle, positioning of cutting and lifting equipment and use of retrieval baskets for ancillary items. The effects will be short-term and should be followed by natural re-colonisation by organisms that live within or on the seabed sediments the northern North Sea. These activities will be planned and controlled to ensure careful placement of baskets or cutting and lifting equipment thereby minimising the area affected.

Placement of the protective cover of rock dump over the bundle will create a long-term modification of the localised area of seabed that will be covered by the rock dump (graded pieces of rock, usually granite). The rock dumped area will provide a habitat that should be colonised by organisms which occur in the North Sea but typically live on, around or within crevices in rocky, rather than sedimentary substrata. These include animals such as anemones, soft corals, tubeworms, hydroids, sponges, bryozoan, tunicates, molluscs and a variety of fish, and shellfish.

The ecological impact from rock dump would be limited to the relatively small (0.05 km^2) and well defined within an extensive area of mainly sedimentary seabed. Additionally, various types of organism that prefer hard substrates would have been found on the external surfaces of the bundles during operational life of the Leadon Field. These marine organisms occur on oil and gas installations throughout the North Sea.

Impact caused by the protective rock dump footprint will be minimised by; creating a seabed profile appropriate for the long-term protection of the pipeline bundle, the controlled deposition of rock via the vessel’s manoeuvrable fall-pipe and placement using a remotely operated vehicle.

Long-term presence of the pipeline bundle

Long term presence of the buried bundle could potentially create an obstruction to fishing vessels using gear to catch species that are found on or near the seabed. The bundle could also potentially become a source of marine debris and pollutants when it eventually loses its structural integrity.

In relation to fishing, the purpose of the protective rock dump is to ensure that fishing gear will not be impeded if it travels across the intact bundle or any material that remains when the bundle eventually corrodes and collapses.

In order to achieve this graded rock will be used to form a 4,254 m long, 12 m wide berm which will provide 0.6m cover over the top of the bundle. The quantity and characteristics of the rock dump were established following consultations with the Scottish Fishermen's Federation (SFF). A slope of 1 in 3 along the full length of the bundle was considered necessary to limit potential impact. Previous over-trawling tests have indicated that the risk would be minimal when using heavy net trawl gear.

Further mitigation will include a post-decommissioning over-trawlability survey overseen by a fisheries liaison officer. SFF will be consulted at all stages of the process.

Structural degradation of the bundle will be long-term process caused by corrosion of the bundle's outer carrier pipe and internal components and the eventual collapse of the bundle under its own weight and that of the overlying rock dump. Through-wall corrosion of carrier pipe is likely to take many decades. Gradual release may occur of a small quantity of oil (15 kg) trapped in pipework, and dissolution of 3.7 t of copper from internal cables and 18.7 t of aluminium-zinc-indium from the sacrificial anodes originally intended to prevent corrosion. The oil release and dissolution of metals to the surrounding water column and sediment beneath the bundle will occur over a long period and in small quantities such that the environmental impact is likely to be negligible.

Corrosion in seawater of the bundle's structural steel components will form ferric hydroxide (rust) which is relatively insoluble and environmentally benign. Natural erosion of the rock dump is likely to be caused by current movements, with 55% of weight loss anticipated over period of 145 years.

Discharges to sea

Discharges to sea of treated water, hydraulic fluid, residual oil, as well as discharges from operating vessels during decommissioning activities will result in localised effects which should have a negligible impact on the wider marine environment.

Noise generation by vessels and cutting operations

Man-made underwater noise has the potential to impact marine mammals. Several activities associated with the Leadon decommissioning operations will generate underwater noise. Records indicate previous sightings of five cetacean species within the study area over the period when decommissioning activities are scheduled to take place. These species are all subject to regulatory protection from injury and disturbance.

Underwater cutting operations may be a significant source of sound associated with the decommissioning activities. However, the proposed cutting operations will be short in duration, lasting a few hours each over a period of days to weeks. Depending on ambient noise levels, sensitive marine mammals may also be locally disturbed by noise from a vessel in its immediate vicinity.

Broadband source levels for these activities rarely exceed about 190 dB re 1 μPa m and are typically much lower This does not exceed the thresholds for injury to cetaceans (Southall *et al.*, 2007). Overall any potential impact to marine mammals is not significant for any of the decommissioning methods and will only result in minimal disturbance.

Atmospheric emissions and energy use from vessels and onshore dismantling operations

Energy use and consequent emissions from the decommissioning activities will have a localised effect on air quality. The impact on air quality is unlikely to affect any receptors in the Leadon area as the impact is expected to be limited to the immediate vicinity of the operations. For this reason, there is also unlikely to be a significant transboundary or cumulative impact on air quality.

Emissions from the decommissioning activities will contribute to greenhouse gas emissions but will be kept to a practicable minimum. Power generation emissions during decommissioning activities will be minimised by advanced planning to ensure efficient operations through well maintained equipment and generators and regular monitoring of fuel consumption. Total CO_2 emissions generated from the proposed decommissioning operations (including gas flowline venting) will represent a small proportion (0.037%) of the of the total annual CO_2 offshore emissions from the UKCS.

Accidental events

The worst case single trajectory modelling suggests a release of diesel fuel would travel a distance of approximately 18 to 19 km either towards the UK coastline or towards the UK/ Norwegian median line. It is likely that the spill will reach and potentially cross the UK/ Norwegian median line before the oil disperses, however, it will not beach. Any impact to sensitive receptors is likely to be negligible as the high proportion of light ends in the diesel mean that the oil will evaporate and disperse within approximately 8 hours.

Environmental Management

Maersk is committed to conducting activities in compliance with all legislation and operates an ISO14001 certified Environmental Management System (EMS) as part of the wider Business Management System (BMS). The EMS covers all aspects of Maersk's activities including exploration, drilling and production activities. All activities associated with the decommissioning of the Leadon infrastructure will be covered by the EMS.

Conclusions

Overall, the ES has evaluated the environmental risk and concludes that Maersk have, or intend to, put in place sufficient safeguards to mitigate impacts and to monitor the implementation of these safeguards.

Therefore, it is the conclusion of the Environmental Statement that the recommended options to decommission the Leadon facilities can be completed without causing significant impact to the environment. Removal of the subsea structure will open the area for other users of the sea and is seen as a beneficial impact.

Intentionally blank page

1.0 INTRODUCTION

This Environmental Statement (ES) presents the findings of the Environmental Impact Assessment (EIA) undertaken by Maersk Oil UK Limited (Maersk) for decommissioning of the Leadon Field including associated pipeline bundles, towheads, Mid Line Structure (MLS), riser bases and subsea infrastructure.

1.1 Location of the Leadon Field

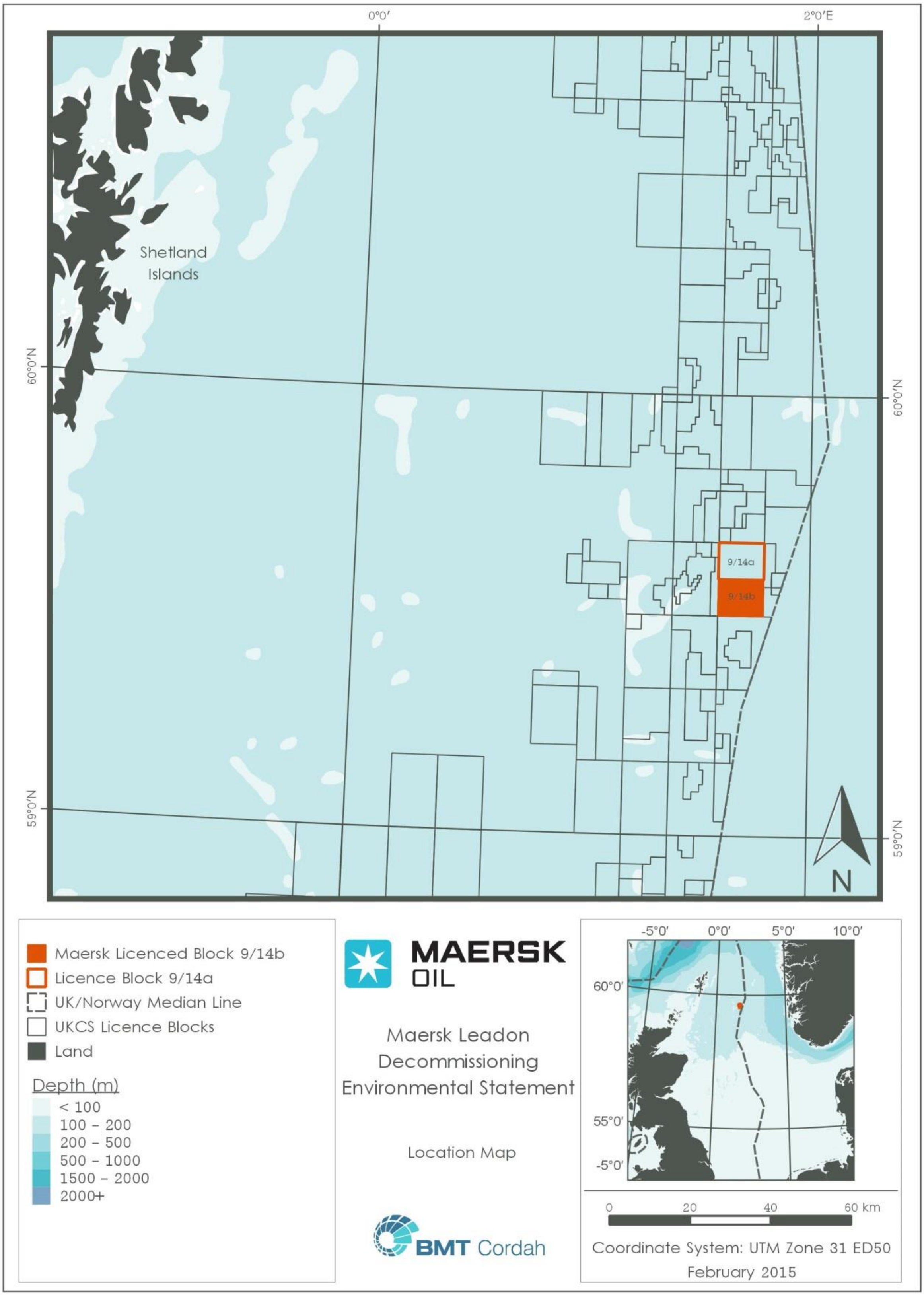
The Leadon Field is located in UK Continental Shelf (UKCS) Block 9/14b of the central North Sea, approximately 190 miles NNE of Aberdeen and 8 km west of the UK/ Norway median line (Figure 1.1). The remaining subsurface infrastructure lies at a depth of 120 m.

1.2 Leadon Project History

The Leadon Field was discovered in March 1989 (DECC, 2013a) and infrastructure was installed in 2001. The original licence assigned to this field was P277 and P090 (UK Oil and Gas Data, 2014) and was operated by Kerr-McGee. Production at the Leadon Field commenced in November 2001; was acquired by Maersk in 2005 and production ceased in 2006. Currently the Leadon Field is licensed under licence number P1763 of which Maersk’s stake is 100%.

1.3 Overview of the Leadon Field

The Leadon infrastructure, installed in 2001, consists of two drill centres, North Drill Centre and South Drill Centre, which are approximately 4.2 km apart and connected by two bundle sections with diameters of 42.5” (1.08 m) and 47.5” (1.21 m), respectively. At each end of the pipeline bundle sections, North and South Towheads, weighing 307 tonnes and 275 tonnes respectively, incorporate all the connections between the individual wells at the drill centres. Halfway along the bundle length, there is an MLS weighing 282 tonnes. The field was produced via the Floating Production Storage and Offloading FPSO vessel (Global Producer III), moored at the midline location (Figure 1.2). A 7.3 km, 4” gas import flowline connected the Leadon MLS with Beryl Alpha.



Sources: DECC, 2013a; UK Oil and Gas Data, 2104.

Figure 1.1: Location of the Leadon UKCS Licence Block 9/14b.

Some preparation work has already been undertaken for the decommissioning of the Leadon facilities. The FPSO and associated mooring system was removed and reused at the Donan Development in 2006; and the flexible risers were recovered and disposed of in 2007. The current layout of the facilities is detailed in Figure 2.2.

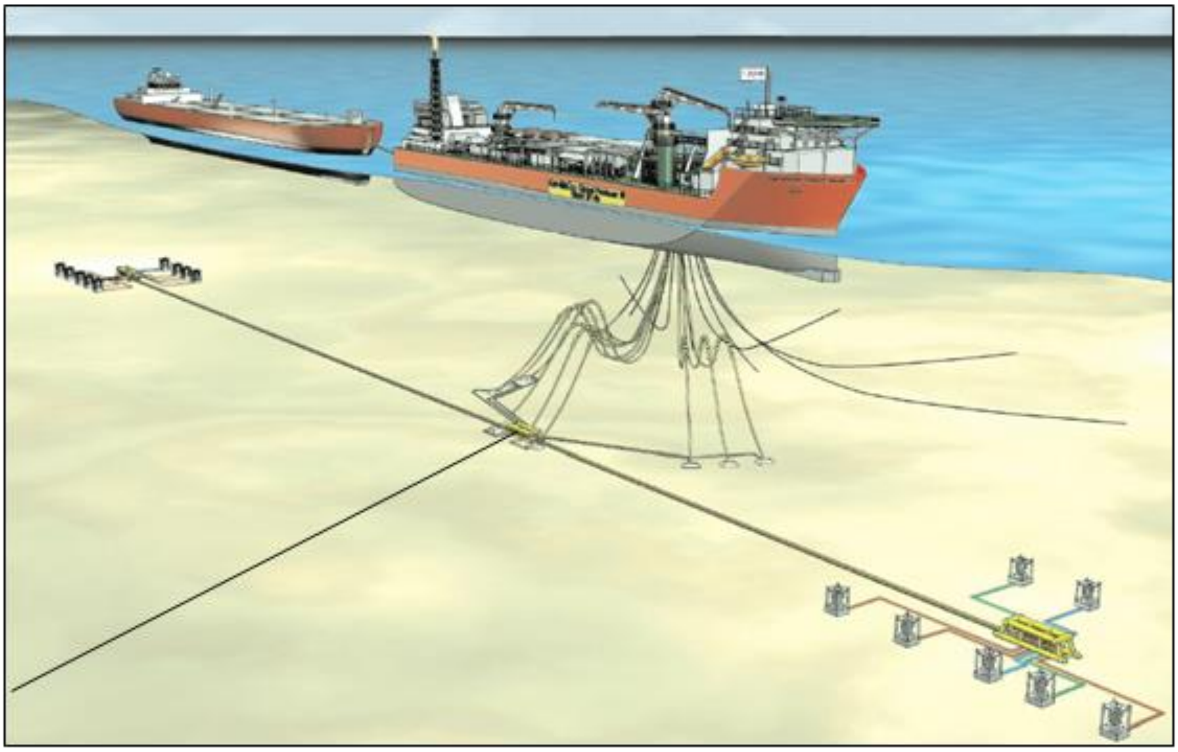


Figure 1.2: Leadon infrastructure and facilities during production (pre-2006)

1.4 Company Overview

Maersk is a midsize international oil and gas company operating with an oil production of about 650,000 barrels per day and a sales gas production of up to some 1,000 million standard cubic feet per day.

The company has a net equity production exceeding 550,000 barrels of oil equivalents per day from fields in the Danish and British parts of the North Sea, offshore Qatar, in Algeria and in Kazakhstan. Exploration activities are on-going in the Danish, British and Norwegian sectors of the North Sea, Qatar, Algeria, Angola, Kazakhstan, Oman, Brazil and the US Gulf of Mexico, amongst others.

1.5 Purpose of the Environmental Impact Assessment

The EIA process was conducted in accordance with the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended) to support the Leadon Field Decommissioning Programme.

The purpose of the EIA process is to understand and communicate the significant environmental impacts associated with the project options to inform Maersk's decision making process. The ES presents the findings of the EIA process and has been prepared as part of the planning and consents process for the decommissioning of the Leadon facilities.

1.6 Legislation

The decommissioning of offshore oil and gas infrastructure in the UKCS is principally governed by the Petroleum Act 1998, as amended by the Energy Act 2008. The Petroleum Act sets out the requirements for a formal Decommissioning Programme which must be approved by the Department of Energy and Climate Change (DECC) before the owners of an offshore installation or pipeline may proceed with decommissioning. At present there is no statutory requirement to undertake an EIA for decommissioning. However, under the DECC Guidance Notes on the Decommissioning of Offshore Oil and Gas Installations and Pipelines under the Petroleum Act 1998 (DECC, 2012) the Decommissioning Programme must be supported by an EIA. The DECC Guidance Notes state that an EIA should include an assessment of the following:

- all potential impacts on the marine environment including exposure of biota to contaminants associated with the installation; other biological impacts arising from physical effects; conflicts with the conservation of species and their habitats;
- all potential impacts on other environmental compartments, including emissions to the atmosphere, leaching to groundwater, discharges to surface fresh water and effects on the soil;
- consumption of natural resources and energy associated with reuse and recycling;
- interference with other legitimate uses of the sea and consequential effects on the physical environment; and
- potential impacts on amenities, the community activities and on future uses of the environment.

In addition, DECC have advised the Oil and Gas Industry that under the Marine and Coastal Access Act 2009 (MCAA) and the Marine (Scotland) Act 2010 an EIA/ ES will be required for all licence applications relating to decommissioning operations. The MCAA licence application will be made at the time of decommissioning and the supporting EIA/ ES updated to reflect detailed engineering design and specific mitigation measures.

OSPAR Decision 98/3 (the Decision) which governs the decommissioning of redundant offshore oil and gas facilities does not include the decommissioning of pipelines (OSPAR, 1998). There are no international guidelines on the decommissioning of disused pipelines. However, the UK Petroleum Act and Pipeline Safety regulations 1996 provide a framework for the safe decommissioning of disused pipelines. A summary of the environmental legislation applicable to this project is provided within Appendix A.

1.7 ES Scope

The scope of this ES is to present:

- an overview of the Leadon Field and the associated Decommissioning Programme;
- the selection process and preferred decommissioning options;
- a description of the local environment and potential impacts; and
- a justification for option selection based on sensitive receptors.

1.8 Report Structure

The Leadon Decommissioning ES structure is detailed below:

Section		Contents
NTS	**Non-Technical Summary**	A non-technical summary of the ES.
1	**Introduction**	An introduction to the project and the ES scope
2	**Project Description**	A description of: decommissioning requirements, the comparative assessment (CA) process and the preferred options
3	**Existing Environment**	A description of the environment and sensitive receptors
4	**Consultation**	Details of the consultation process and outcomes
5	**Risk Assessment**	A description of the risk assessment approach and findings
6	**Seabed Disturbance**	Identification of potential sources of impact to environmental and socioeconomic receptors, and details of practicable mitigation strategies
7	**Physical Presence**	
8	**Discharges to Sea**	
9	**Noise Generation**	
10	**Atmospheric Emissions and Energy Use**	
11	**Accidental Events**	
12	**Environmental and Waste Management**	A description of Maersk's environmental and waste management procedures and their application during decommissioning.
13	**Conclusions**	Key findings and conclusions

Intentionally blank page

2.0 THE PROPOSED PROJECT

This section provides a description of the infrastructure remaining at the Leadon site. Maersk are committed to the removal of subsea infrastructure, pipelines and associated debris. Where removal is the preferred option, a comparative assessment (CA) has been undertaken to identify the removal option with the lowest overall risk. Where complete removal is not feasible, CAs have been undertaken to derive the best available options for their decommissioning strategy. The selected decommissioning strategies will be discussed in further detail in this section.

2.1 Overview

Some preparation work has already been undertaken for the decommissioning of the Leadon facilities, with the FPSO and associated mooring system, and the flexible risers having been removed. The decommissioning programme encompasses the removal of all remaining surface laid infrastructure in the Leadon Field where recovery is practicable; and the mitigation strategy, when removal does not represent best available technique (BAT).

2.2 Infrastructure to be Decommissioned

The decommissioning programme will encompass the removal, derogation or mitigation for the following:

- structures including wellheads, towheads, the MLS and riser bases;
- surface-laid pipelines, flowlines and connectors; and
- ancillary materials i.e. concrete mattresses and grout bags.

A summary of the location and co-ordinates for key infrastructure is provided in Table 2.1. Key infrastructure for consideration in the decommissioning programme is highlighted in Figure 2.1. Appropriate decommissioning methodologies for the Leadon infrastructure have been characterised by infrastructure design and their component materials. Leadon infrastructure data are provided in detail in the Leadon Decommissioning Study Inventory (PDI, 2009a) and have been summarised in Table 2.2. Figure 2.2 presents a schematic illustration of the current Leadon Field infrastructure.

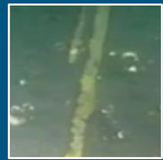
Table 2.1: Co-ordinates of the main Leadon infrastructure

	Main Leadon infrastructure	Location	Latitude and Longitude
A	North Towhead	Leadon Field	59° 34' 49.38"N, 01° 39' 13.48"E
B	South Towhead		59° 32' 31.63"N, 01° 39' 23.80"E
C	MLS		59° 33' 40.97"N, 01° 39' 18.22"E
D	North Bundle	Terminates at A and C	
E	South Bundle	Terminates at B and C	
F	Gas import flowline	From Beryl Alpha (7.5 km to the west) to MLS (C)	
I	Riser bases (six)	Clustered around the MLS (C)	

(i). Towhead structure; (ii) Riser base; (iii) MLS; (iv) North Bundle;, (v) Mattress; (vi) South Bundle

Figure 2.1: Key Leadon project infrastructure requiring decommissioning

Table 2.2: Leadon project materials inventory

	Material	Riser Bases	Mattresses	Towheads & MLS	North Bundle	South Bundle	Beryl Gas Import line	Spoolpieces & jumpers	Total Material
									
Materials	Carbon Steel	483.92 T		864 T	1,902.63 T	2,349.5 T	80.30 T	65.07 T	5,261.5 T
	Stainless Steel				15.56 T	14.5 T	42.00 T		72.06 T
	Duplex Steel				5.29 T	3.72 T		26.35 T	35.36 T
	Copper				1.86 T	1.88 T			3.74 T
	Aluminium-Zinc-Indium Alloy	3.86 T		10.6 T	8.316 T	10.46 T			29.37 T
	LDPE Foam Insulation				59 m^3	92 m^3			151 m^3
	Carbon Steel Ballast Chains				117.5 T	150.5 T			268 T
	Polythene TP11						14.77 T		14.77 T
	Polythene TP14						11.12 T		11.12 T
	Syntactic Polyurethane Insulation							4.98 m^3	4.98 m^3
	Concrete (202 mattresses)		1,018 T						1,018 T
Chemicals & residual fluids	Treated Seawater**	9 m^3		36 m^3	438.28 m^3	609 m^3		31.20 m^3	1,114 m^3
	Transaqua HT2				1.02 m^3	1.03 m^3			2.05 m^3
	Bundle contents ***				1125 m^3	1375 m^3			2,500 m^3
	Oil residue				8.79 kg	6.3 kg		0.48 kg	15.57 kg
	Hydrocarbon Gas						57.4 m^3 *		57.4 m^3

At ambient seabed pressure (0.6 T); ** Treated Seawater – 1,600 ppm, TROS 650; * seawater with biocide concentration 50 ppm*

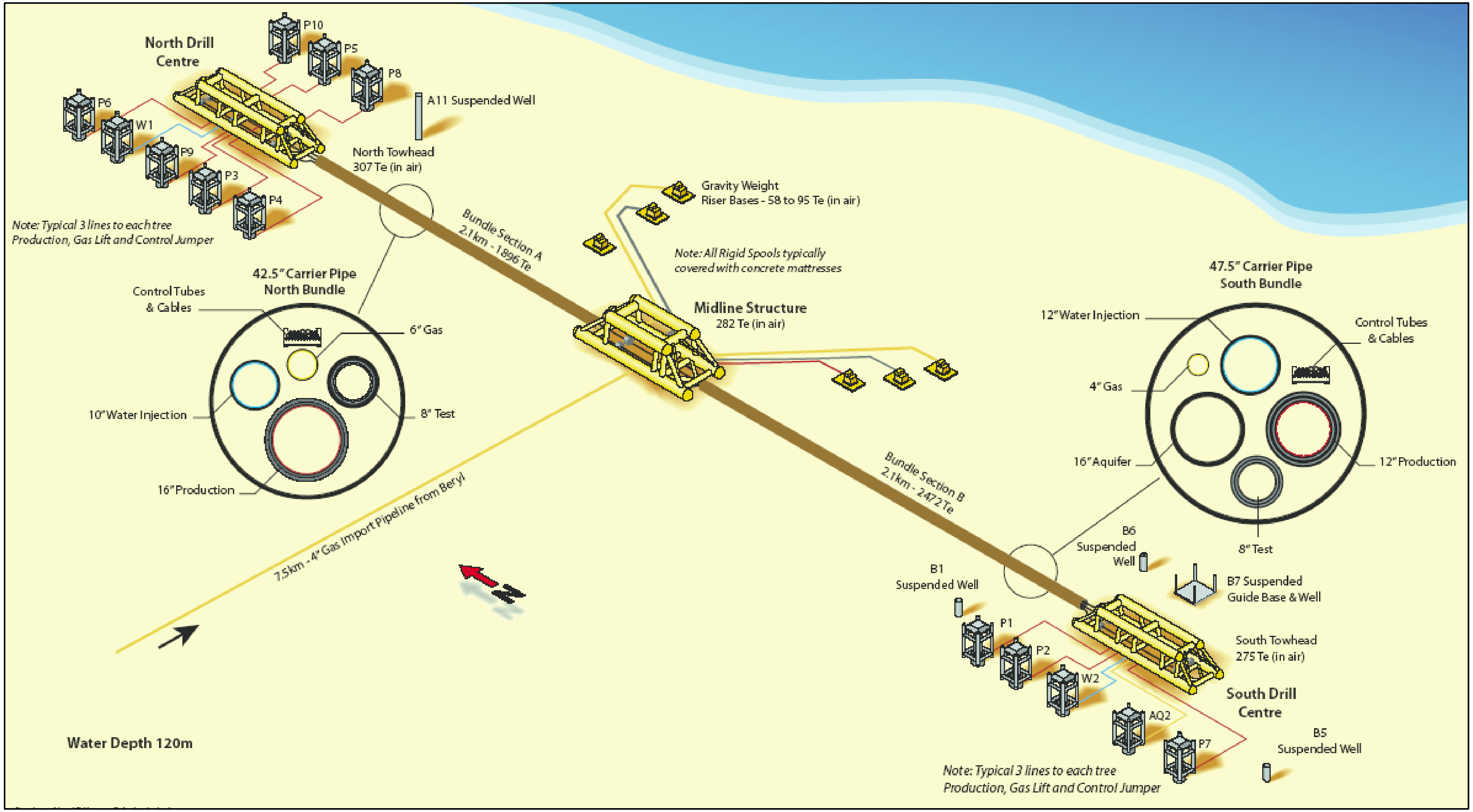


Figure 2.2: Schematic of the Leadon project infrastructure

2.2.1 Subsea Structures

All subsea structures in the field will be completely removed and recovered onshore for recycling and/ or disposal. It is expected that the structure sections will be offloaded at a specialist decommissioning facility where they will be cleaned and where over 95% of the material will be recycled. For an inventory of all structure materials see Table 2.2. All structures for recycling and/ or disposal will be consigned to a recognised and licensed decommissioning and disposal contractor.

Towheads and MLS

At each drill centre location, the bundle is terminated in a towhead structure which incorporates all connections between flowlines and the individual wells (Figure 2.2). A similar MLS is located halfway along the bundle length and contains the connections between the bundle and the riser bases. These structures will be removed and recovered to shore for recycling and/ or disposal. None of the structures are piled.

Riser bases

Six gravity riser base structures clustered around the MLS are to be decommissioned (Figure 2.2). Riser bases will be removed and recovered to shore for recycling and/ or disposal.

Wellhead structures

The Leadon Field comprises 18 wells split between the North and South Drill Centres. North Drill Centre (Block 9/14a) has seven production wells, one water injector and one suspended well. South Drill Centre (Block 9/14b) consists of three production wells, one water injector, one aquifer and four suspended wells. Well details are summarised in the Leadon Decommissioning programme (Maersk, 2014).

All wells will be suspended in accordance with UK Guidelines. The base case methodology for abandonment of the Leadon wells is summarised in the Leadon Decommissioning programme (Maersk, 2014). Wellhead structures will be removed and recovered to shore for recycling and/ or disposal by a recognised and licensed decommissioning and disposal contractor. Plugging and abandonment of wells is not covered in this ES.

Various removal methods for the subsea infrastructure were outlined during the CA process and will be discussed further in Section 2.3.

2.2.2 Pipelines, flowlines and connectors

Previous infrastructure for decommissioning includes pipeline bundles, flowlines, jumpers and associated control systems.

Bundles

The North and South Drill Centres are connected by two bundle sections, North Bundle (PL1841) and South Bundle (PL1842). The bundle sections consist of various flowlines and control systems that bring services and production to and from the wells (Figures 2.1 and 2.2).

The bundle sections are exposed on the seabed and are designed to be over-trawlable. Since installation in 2001, a degree of backfill has occurred, although the bundle sections are not completely buried at any location. The most recent surveys (Maersk, 2011; 2013) did not identify any areas of freespan and a comparison of the bundles' burial status (Maersk, 2009) since installation indicates that the lines are stable.

Remotely Operated Vehicle (ROV) inspection during 2009 showed that both the North and South Bundles are generally in good condition with no obvious signs of coating damage, significant debris or defect. The carrier pipe was 100% exposed for the entire length (ISS, 2009).

During the CA process, two decommissioning options were considered for the pipeline bundle. Maersk decided the best option would be to protect the bundle by burial, using existing concrete mattresses and rock dump. This option will be discussed further in Section 2.6.

Gas import flowline

A 7.4 km, 4" gas import flexible flowline (PL1895) runs between a valve structure within the Beryl Alpha 500 m zone and the Leadon MLS. The flowline is laid in an open trench which has accumulated a degree of natural backfill since installation. The line remains filled with hydrocarbon gas at ambient pressure, with a 50 m monoethylene glycol (MEG) slug injected at the Leadon end of the flowline. The flowline crosses several lines within the Beryl Alpha 500 m zone and is crossed in one location by the Apache operated Skene North Bundle Replacement (NBR). The crossings are generally constructed from grout bags and mattresses positioned to provide a smooth ramp over the flowline to be crossed. The flowline will be cut at each crossing point to avoid disturbing other lines, and a terminal cut made at the edge of the Beryl 500 m exclusion zone. The flowline will be removed and recovered to shore via a reverse reel process. It will be recycled and/ or disposed of by a recognised and licensed decommissioning and disposal contractor.

Jumpers & spoolpieces

In total approximately 100 tonnes of spoolpieces and jumpers, ranging in diameter from 2" to 12" and currently protected by concrete mattresses, are to be decommissioned. All spoolpieces and jumpers in the field will be removed and recovered to shore for recycling and/ or disposal. It is anticipated that up to 95% of the recovered material may be recycled.

2.2.3 Ancillary material

Drill cuttings

After analysis of the drilling data it was concluded that the Leadon Field did not require full Stage 1 screening, as required under OSPAR 2006/5. For Leadon this assessment was made on the following basis:

- Only two Leadon wells have been drilled with Oil Based Mud (OBM) discharge.
- The two wells were drilled at some distance from each other and cannot be seen as contributing to a single cuttings pile as defined by the OSPAR recommendation.

- Although drilling history was unavailable for a number of wells which have been drilled, these were single well sites or were drilled after the cessation of OBM discharge (1st January 2001 in Maersk fields).

On this basis it is anticipated that no further decommissioning actions will be required for drill cuttings in the Leadon Field.

Concrete mattresses and grout bags

Mattresses are used for spoolpiece and jumper protection as well as flowline stabilisation and crossing construction. In total there are 200 mattresses on site at Leadon. In line with DECC Guidance, all mattresses not reusable on site will be recovered for disposal onshore.

Grout bags are used for stabilisation and crossing construction. In total there are 2000 grout bags on site at Leadon. In line with DECC Guidance all grout bags that are not reusable, will be recovered from the seabed for disposal onshore, wherever practicable. Retrieval of mattresses and grout bags will be undertaken using speed loaders and 4 X 2 m ($8m^2$) baskets.

Debris

Surveys of the Leadon facilities (Maersk, 2009; 2011; 2013), have identified no significant items of debris to be considered. To ensure that any remaining debris is removed, a post-decommissioning debris survey will be undertaken and appropriate removal actions completed.

2.3 Overview of Options and the CA Process

This section provides a brief description of the CA process and summarises the main decommissioning options considered for the Leadon project. The categorising of the decommissioning options is an important part of the study and informs many of the recommendations that are made. The CA demonstrates that a rigorous evaluation methodology and decision making processes has been adopted when discounting or endorsing a particular option.

2.3.1 Leadon CA I process

As per DECC guidelines, Maersk have developed a Decommissioning Programme for the Leadon Field. This incorporated a Front-End Engineering Design (FEED) study, to identify decommissioning options considering all technical and environmental issues, generating cost estimates and schedules.

An important part of the FEED study was the CA I which provided a tool against which each option could be compared against one another (PDI, 2009b). The various assessment criteria were quantified (if applicable), to allow each aspect of the operations to be classified as low, medium or high risk, with regards to the following:

Safety	**Reputation**	**Technology**	**Society**
Environment	**Economy**	**Ongoing Liability**	

Leadon decommissioning options for each item of subsea infrastructure was assessed in CA I (PDI, 2009b). The results of CA I are outlined in Table 2.3.

2.3.2 Leadon CA I process summary

Based on the outcomes of CA I, it was decided that the best option for the removal of structures (including the wellheads, towheads, MLS and spoolpieces) was to cut and recover. Reverse reel was the preferred option for recovery of the gas flowline.

The option to leave the mattresses on site carries a lower CA rating, however, DECC guidance indicates that focus should be placed on their removal. The CA suggested that should the decision be made to leave the bundles in place, that some of the mattresses would be reused as protective covers.

During consultation with DECC, the recommended decommissioning option for all infrastructure outlined in Table 2.3 were considered to be well defined and understood. However, it was recommended that the options for bundle decommissioning required further assessment.

Table 2.3: Comparative assessment summary (CA I)

Criteria	Best Option	Comments
Structures		
Risk to other sea users	Cut and recover	Risk to the subsea environment from submerged tow
Carbon emissions		Lower vessel use for cut and recover option
Technical challenge		Cut and recover is tried-and-tested
Risk of project failure		
Risk to company		
Hydrocarbon discharge	Submerged tow	Submerged tow is a relatively new concept. For a submerged tow there is no requirement to break containment of the towheads or MLS
Chemical discharge		
Flowline		
Risk to personnel	Reel recovery	Reel recovery is a well-understood activity that requires minimal handling by personnel, whereas cut and recover would require extensive operations to cut and secure the flowline in pieces on board the vessel
Economic		Given the effort required to cut the flowline, reel recovery is a more economically viable option
Spoolpieces		
Economic	Cutting equipment	Estimated cost involved in the use of cutting equipment is less due to the associated reduction in Diving Support Vessel (DSV) time
Mattresses		
Risk to personnel	Leave on site	Reduced handling of mattresses on deck if left on site
Risk to those on land		Higher if removed and recycled/ disposed to landfill
Carbon emissions		Less vessel use involved if left on site
Amenities		A total of 200 mattresses would have to be recycled/ disposed of if recovered
Risk to other users of the sea	Recover	Potential fishing hazard if left on site
Material recovery		All mattresses recovered
Ongoing liability		Mattresses would require post-decommissioning monitoring if left on site

2.3.3 Leadon CA II process – bundle options

Further evaluation of the options and implications of bundle decommissioning was undertaken based on a post FEED study (including a risk assessment and an EIA). This led to a second CA to more clearly define the decommissioning options for the bundle (PDI, 2012).

2.3.4 Description of bundle decommissioning options

During the course of the study numerous options were considered for Leadon bundle decommissioning. Identified options were investigated on the basis of:

Current Status	**Pros/ Cons**	**Liability**	**Cost**
Equipment	**Duration**	**Vessel Specifications**	

2.4 Bundle Decommissioning Options Considered

The following options were discounted in CA I with regard to bundle decommissioning:

- In place decommissioning - Trench bundle in current location.
- In place decommissioning – Move bundle to pre-cut trench.
- Full removal – Tow bundle to shore.

The discounted options presented significant technical challenges and are unprecedented in the North Sea due to large diameter of the bundle. For a more detailed analysis of these options refer to the Decommissioning Programme (Maersk, 2014).

The following options were taken forward based on their feasibility and further reviewed in CA II:

Option 1:	**Leave in place – Rendered Over-trawlable**
Option 2:	**Complete Removal - Cut & Recover**

2.4.1 Option 1: Leave in place

This option involves undertaking an over-trawlability check on the bundle, removing any potential snagging hazards then protecting the bundle with rock dump. Rock dump will be laid on either the exposed bundle ends (at each towhead terminus and across the MLS gap) or along the entire length of the bundle.

2.4.2 Option 2: Complete removal

This option involves subsea cutting of the bundle into sections and then recovering to a supply vessel (or similar) for transportation onshore for disposal.

2.5 Final Option Selection for Bundle Decommissioning

The comparative assessment utilised a combination of quantitative and qualitative methods to assess each of the decommissioning options. Each option was considered against a set of assessment criteria and assigned a score based on a combination of the impact and the confidence in the assessed impact rating. The matrices used for the comparative assessment are presented in the Decommissioning Programme (Maersk, 2014). The results of the bundle option CA II are shown in Figure 2.3.

The assessment indicated that the “leave in place” option was the best option under eleven of the criteria assessed, compared to “complete removal” being judged as the best option under six of the criteria (Figure 2.4). This was also reflected in the overall average comparative scores, where “leave in place” was scored at 3.4 compared to 6.3 for “complete removal” (Figure 2.3). Of note, when considering safety, “leave in place” was assessed as the preferred option in 3 of the 4 criteria.

Assessment Criteria	Matters to be considered	Assessment			
		Option 1 - Leave in place		Option 2 - Complete removal	
		Score	Average	Score	Average
Safety	Risk to personnel - topsides	2	2.4	9	6.6
	Risk to Personnel - subsea	2		12	
	Risk to other users of the sea	6		2	
	Risk to those on land	1		9	
	Risk to 3rd party assets	1		1	
Environmental	Physical Presence	6	2.7	1	2.1
	Seabed Disturbance	4		1	
	Noise & Vibration	2		6	
	Atmospheric Emissions	2		2	
	Marine Discharges	1		1	
	Solid Waste	1		1	
	Minor Loss of Containment	3		3	
Technical	Technical challenge	1	1.8	8	11.8
	Level of diving intervention	3		15	
	Weather Sensitivity	2		15	
	Risk of major project failure	1		9	
Societal	Fisheries impacts	6	4.0	1	6.3
	Amenities	3		12	
	Communities	3		6	
Reputation	Risk to company	9	9.0	2	2.0
Ongoing liability	Ongoing liability	9	9.0	2	2.0
Economic	Economic	6	6.0	20	20.0
	Average CA Score	**3.4**		**6.3**	

Key:

LOW	MED	HIGH

Figure 2.3: Comparative assessment II scoring summary

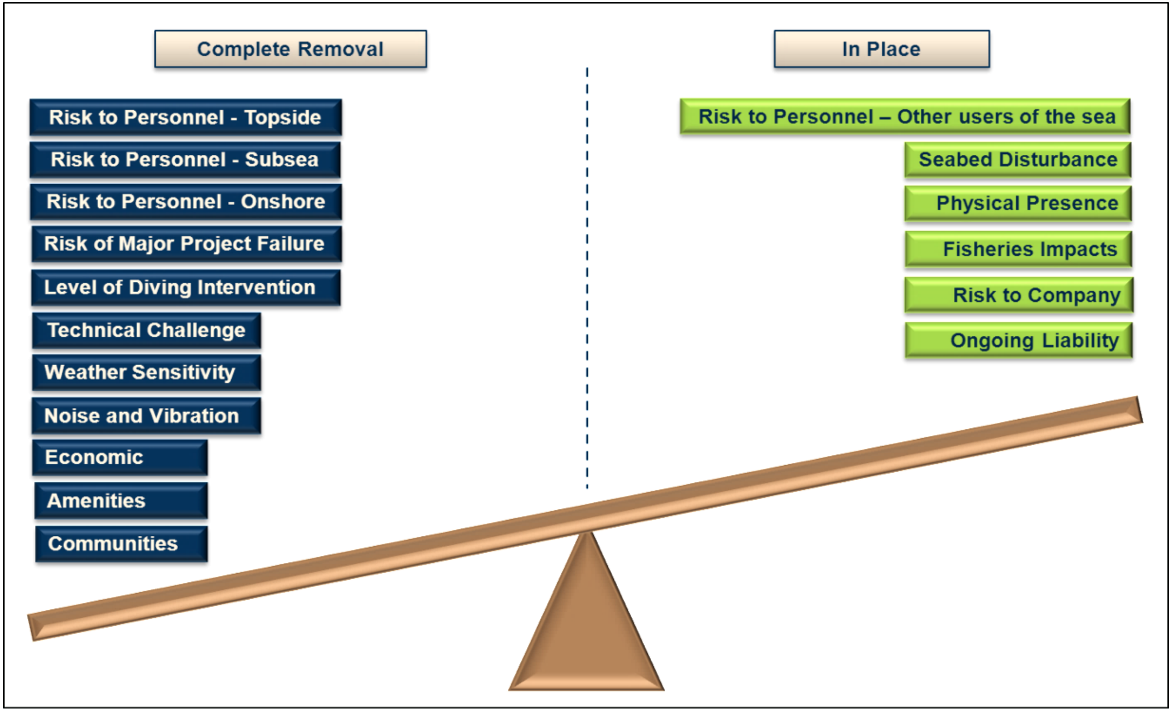


Figure 2.4: Comparative assessment II results

2.5.1 Preferred strategy options

Table 2.4 outlines the pros and cons of the "leave in place" strategy; with the options consisting of either trenching the bundles or burial (rock dump).

Table 2.4: Comparative assessment summary

Criteria	Best Option	Comments
Bundle decommissioning: "leave in place"		
Risk to third party assets	Burial	Due to the size of the bundle and substrate conditions, there is a possibility of damage to the trencher
Seabed disturbance		Higher level of disturbance caused by trenching operations
Carbon footprint		Greater contribution to CO_2 emissions due to increased vessel use during trenching/ burial operations
Technical challenge		Limited choice of trenchers available to carry out an operation on this scale
Risk of project failure		Limited choice of trenchers available to carry out an operation of this scale
Economic		Costs are significantly higher for trenching/ burial operations due to the increased vessel use.
Ongoing liability	Trench	Trenching the bundle would limit the requirement for ongoing post-decommissioning monitoring surveys.

2.5.2 Leadon CA II Process Summary

Based on this assessment it is concluded that the most appropriate option would be to leave the bundle in place, with burial using existing concrete mattresses and rock dump.

2.6 Description of preferred option – Leadon bundle burial

Based on the options outlined in Table 2.4, this ES will focus on the impact to the environment for the burial option.

Short term - terminus burial

The initial short term decommissioning strategy will entail a partial rock dump of the exposed bundle termini and midline ends. This is currently considered the best practicable environmental option (BPEO); as it provides the opportunity for future technologies to develop to the point where recovery can be managed within an acceptable level of risk.

After initial burial of bundle terminus ends, routine inspections will identify any significant exposure that could lead to a snagging risk. If during inspections and over-trawability trials areas of freespan or snagging risk are identified, Maersk will conduct further remedial rock dump. In the unlikely scenario that such remedial action will be required, Maersk will consult with DECC prior to undertaking further works.

An inspection programme is currently not defined. Maersk will inform and liaise with DECC in defining an inspection programme. The last inspection was in July 2013 and the next will follow completion of decommissioning activities,

Complete burial

The following chapters will consider a worst case impact, namely the rock dump of the entire length of the two bundle sections.

The remedial rock dump strategy will use graded crushed rock placed over the bundles in a carefully controlled operation using a dedicated rock dump vessel equipped with a dynamically positioned fall pipe. The operation will be monitored by an ROV during placement and after completion to confirm that the proper placement of the material.

2.6.1 Rock dump profile options

The rock dump will be shaped to render it over-trawlable. The maximum quantity of rock that may be placed on the bundles to provide complete protection is estimated to be between 69,000 and 83,700 tonnes. The rock will be placed in one of two configurations, a trapezoid or triangular design. A triangular design will require 69,000 tonnes, with an estimated footprint of 0.034 km^2. A trapezoidal design will require 83,700 tonnes with an estimated footprint of 0.042 km^2. Both options have been confirmed as acceptable to SFF.

Table 2.5: Summary of Rock dump statistics for the Leadon bundles

Bundle	Profile	Cover Height (mm)	Rock Berm Height (m)	Top/Bottom Rock Berm width (m)	Profile cross section (m^2)	Rock Volume (m^3)		Rock Weight (Te)
						Ends	Bundle	
North (42.5")	Triangular	550	1.65	9.9	7.1	810	14,200	30,000
South (47.5")		650	1.85	11.1	9.2	1,060	18,400	39,000
North (42.5")	Trapezoidal	400	1.50	1.9/10.9	8.4	950	16,800	35,500
South (47.5")		500	1.70	2.2/12.4	11.4	1,300	22,800	48,200

2.6.2 Rock dump option timeframe

As the UKCS decommissioning market develops, the safety and efficiency of bundle recovery techniques and equipment may improve to a level that makes complete removal of the Leadon bundle viable. Therefore the preference is to defer the complete rock dump of the lines based on the anticipated corrosion rate of the bundle. Deferment is currently estimated to be greater than 25 years.

2.6.3 Preparatory works on bundle sections

The burial status of the two bundle sections has been assessed in recent surveys (Maersk 2011; 2013). These recent surveys of the bundle report no freespan areas along its length.

A comparison of surveys undertaken in 2006 and 2009 (Maersk, 2009) shows that the backfill to the 3 to 6 o'clock position along the bundle has increased. Figure 2.5 presents a comparison of the burial status for two reference points on the North Bundle section. The images above were taken in 2006 and the images below are from the corresponding locations in 2009. On the basis of this historical survey data, it is not anticipated that any areas of freespan will develop over time. Burial status was further confirmed by diver operations in 2010.

2.6.4 NORM and/or LSA scale

Naturally Occurring Radioactive Material (NORM) and/ or Low Specific Activity (LSA) scale have not been reported following decommissioning of the FPSO from the Leadon Field; in either the flowline risers or the production separators. NORM or LSA scale deposits are not expected as part of the bundle decommissioning process. Despite this, all recovered pipework will be monitored for NORM and/ or LSA scale. Should any such scale occur then deposits will be tagged, handled and quarantined accordingly in the event that it is encountered.

Figure 2.5: Pipeline bundle survey imagery for two bundle reference points in 2006 (top row) and 2009 (bottom row)

2.7 Post Decommissioning

The following sections detail Maersk's strategy post decommissioning.

2.7.1 Debris Clearance

Recent surveys of the Leadon facilities have identified minimal debris accumulation through the operating life of the field (Maersk, 2009; 2011; 2013). In order to ensure that this debris along with any arising from the decommissioning activities is identified and recovered, debris surveys by ROV will be conducted in following key areas:

- within a 500 m radius of the North/ South Drill Centres and MLS; and
- within a 200 m corridor along the North/ South Bundles and gas import flowline route

Upon verification of the seabed clearance by an independent organisation a clearance certificate will be provided by the Scottish Fishermen's' Federation (SFF) and presented to DECC along with the decommissioning closeout report (Maersk, 2014).

2.7.2 As Left Surveys

Surveys will be carried out of the areas where infrastructure has been removed as well as for the areas covered by bundle sections which are to be decommissioned in place.

Seabed samples will be taken at the locations where equipment has been removed from the site (to be agreed with DECC) to confirm if the seabed is returning to its original condition. As part of the final operations at Leadon, seabed samples will be collected around the drill centre sites. Should samples identify any residue from drill cuttings then additional samples will be obtained in 12 months later as part of a monitoring regime.

2.7.3 Monitoring Regime

A carefully planned and structured monitoring regime will be required to ensure that the Leadon infrastructure that is decommissioned in place is maintained in a safe condition.

It is anticipated that the first survey will be carried out 12 months after completion of the decommissioning works. This will be discussed and agreed with DECC following submission of a close out report. Thereafter it is anticipated that Leadon will become part of Maersk's ongoing UKCS survey operations which at present are conducted every two years for operational assets.

2.7.4 Bundle monitoring regime

Following the implementation of the partial rock dump option, an important part of the post-decommissioning surveys will be to monitor the wall thickness of the bundle carrier pipe as well as the burial status and development of any areas of freespan. It is anticipated that the burial status will continue to improve and as such it is unlikely that any freespan will develop, however, the burial status and wall thickness will be monitored at designated reference points. This will ensure that the corrosion profile of the bundle is consistent with that predicted in the corrosion assessment (Maersk, 2013) and that the burial status is well understood.

As part of Maersk's ongoing liability for the Leadon infrastructure, trial trawl sweeps of the bundles and the installed protection will be completed periodically. The procedure for these trials and their frequency will be planned and agreed in conjunction with the SFF. If trials fail, additional rock dumping will be conducted as soon as possible.

Should the decision to fully rock dump the bundles be taken at any point in the future, then a comprehensive bundle integrity survey and modelling regime will be employed to ensure the success of the rock dump strategy.

2.8 Project schedule

The proposed schedule for decommissioning activities at Leadon is shown in Figure 2.6. The schedule also accounts for decommissioning operations that have already been undertaken, which includes cleaning and flushing of the Leadon system, removal of the FPSO and recovery of the risers. Subsea infrastructure decommissioning and well plug and abandonment will not be continuous. The anticipated timescale for decommissioning activities, allows for a flexible approach with decommissioning contractors, to achieve the most efficient and cost effective solution. The schedule doesn't account for the ongoing survey and maintenance regime for the "Leave in place" option for the Leadon bundle.

The range of vessels and equipment to be used during the Leadon Decommissioning Programme will be determined during FEED and the later stages of detailed design and procurement. Vessels will be those typically used in offshore construction and decommissioning projects, including those involved routinely in construction support, dive support, supply, pipeline installation, repair and removal, rock dump placement and surveys.

Figure 2.6: Anticipated project timescale

3.0 EXISTING ENVIRONMENT

This section describes the baseline environmental setting of the planned Leadon decommissioning operations and to identify those components of the physical, chemical, biological and socioeconomic components that might be sensitive to the potential impacts arising as a result of the proposed activities. An understanding of the environmental sensitivities at the local and regional level informed the assessment of the environmental impacts and risks associated with the proposed decommissioning activities.

3.1 Leadon Field Surveys

The following surveys have been undertaken in the Leadon Field:

- **A 2000/2001 Environmental Baseline Survey around the Leadon Development** (Gardline Surveys, 2001). An environmental baseline survey was carried out during December 2000 by Gardline Survey Ltd. (Gardline Survey, 2001). The objective of the survey was to define the environmental conditions (physico-chemical and biological) of the sediments around the well locations and provide data for description of the seabed biological community in terms of macrofaunal species composition and abundance. The environmental sampling was undertaken in a form of grid template with stations evenly spaced at approximately 500m, utilising 0.1m^2 Day grab, covering the Leadon Field around the location of the FPSO, North and South Drill Centres.
- **A 2001 Leadon Bundle Installation and Off-bottom Tow Area Pipeline Route Survey** (Svitzer, 2001). The north and south pipeline route survey was carried out during December 2000 and January 2001 by Svitzer Limited (Svitzer, 2001). The purpose of the survey was to determine the suitability of the proposed bundle route, and identify any shallow geological or topographical conditions that could impair bundle laying operations. The survey was completed using analogue geophysical equipment.
- **Bundle Survey Comparison 2006-2009.** (Subsea Decommissioning, 2010). A comparison was undertaken the compare the results of two pipeline integrity surveys. The 2009 survey footage shows that the majority of the bundle remains exposed. At the time of the survey, sediment was accumulating adjacent to the bundle; it is suggested that over time the bundle might undergo self-burial. No areas of freespan were identified in the 2009 survey.
- **A 2011 ROV Inspection Campaign.** An ROV survey of most of the subsea infrastructure was undertaken in 2011 (Maersk, 2011).
- **A 2013 Subsea Inspection Programme.** An ROV inspection campaign of the remaining infrastructure was undertaken in July 2013 (Maersk, 2013).

3.2 Hydrographic Conditions

The physical environment that is characteristic of the Leadon Field is described in the following subsections.

3.2.1 Water Masses, Currents and Tidal Streams

The speed and direction of the water currents have a direct effect on the transport, dispersion and ultimate fate of any discharges during offshore installation work and operation. Figure 3.2 shows the pattern of current driven water movement in the northern North Sea in relation to the Leadon Field.

The northern North Sea is an area of interaction of several distinct water masses. Atlantic water flows in a north-easterly direction to the north of the Shetland into the Norwegian Sea. Some of this Atlantic water also moves south and enters the North Sea as a bottom moving current. This forms the main inflow into the North Sea and is balanced by the Norwegian Coastal Current that travels in a northerly direction, immediately to the east of the southerly flowing Atlantic water (NSTF, 1993).

Tidal currents in the northern North Sea area are generally weak and are readily influenced by other factors such as winds and density driven circulation. This results in a relatively atypical pattern to the tidal currents. Maximum tidal rates at the location are 0.26 and 0.10 m/s, respectively for spring and neap tides (Hydrographer of the Navy, 2000). The combination of the general circulation and the tidal currents result in relatively unpredictable currents at any given time, owing to the influence of prevailing winds.

Waves are the result of the action of wind on the surface of the sea and their size depends upon the distance or fetch over which the wind can operate. The wave climate in the northern North Sea is a combination of background swell and local wind generated waves. Waves vary seasonally with wave height of 4 m being relatively common in winter (approximately 20% occurrence) but rare in summer (less than 5%) (Hydrographer of the Navy, 2000). In the vicinity of the Leadon infrastructure, significant wave heights exceed 4 m only about 10% of the time (Table 3.1).

Table 3.1: Yearly significant wave height in the Leadon area

10% Exceedance	25% Exceedance	50% Exceedance	75% Exceedance
4.0 m	3.0 m	2.5 m	1.5 m

Source: UKDMAP, 1998.

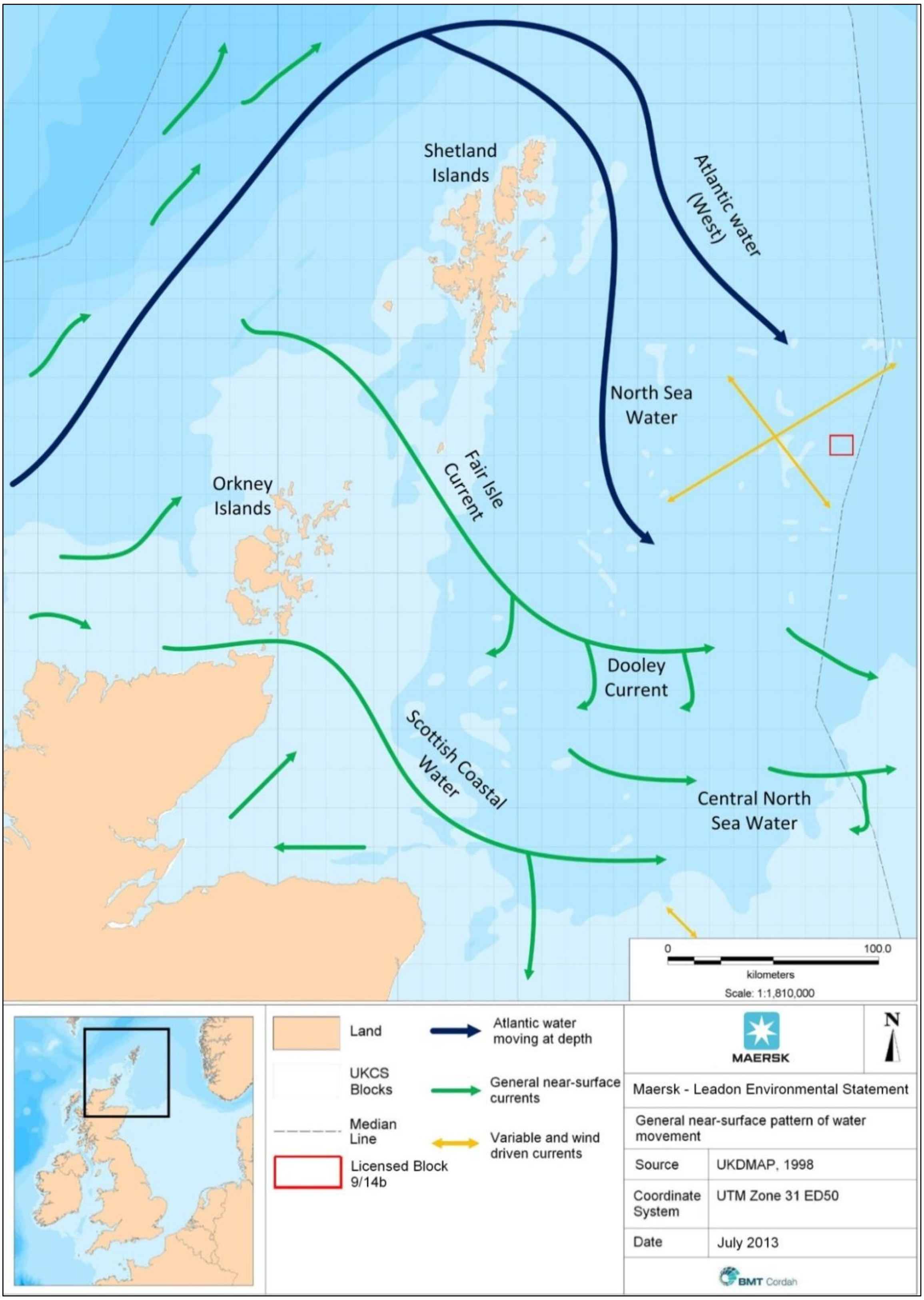
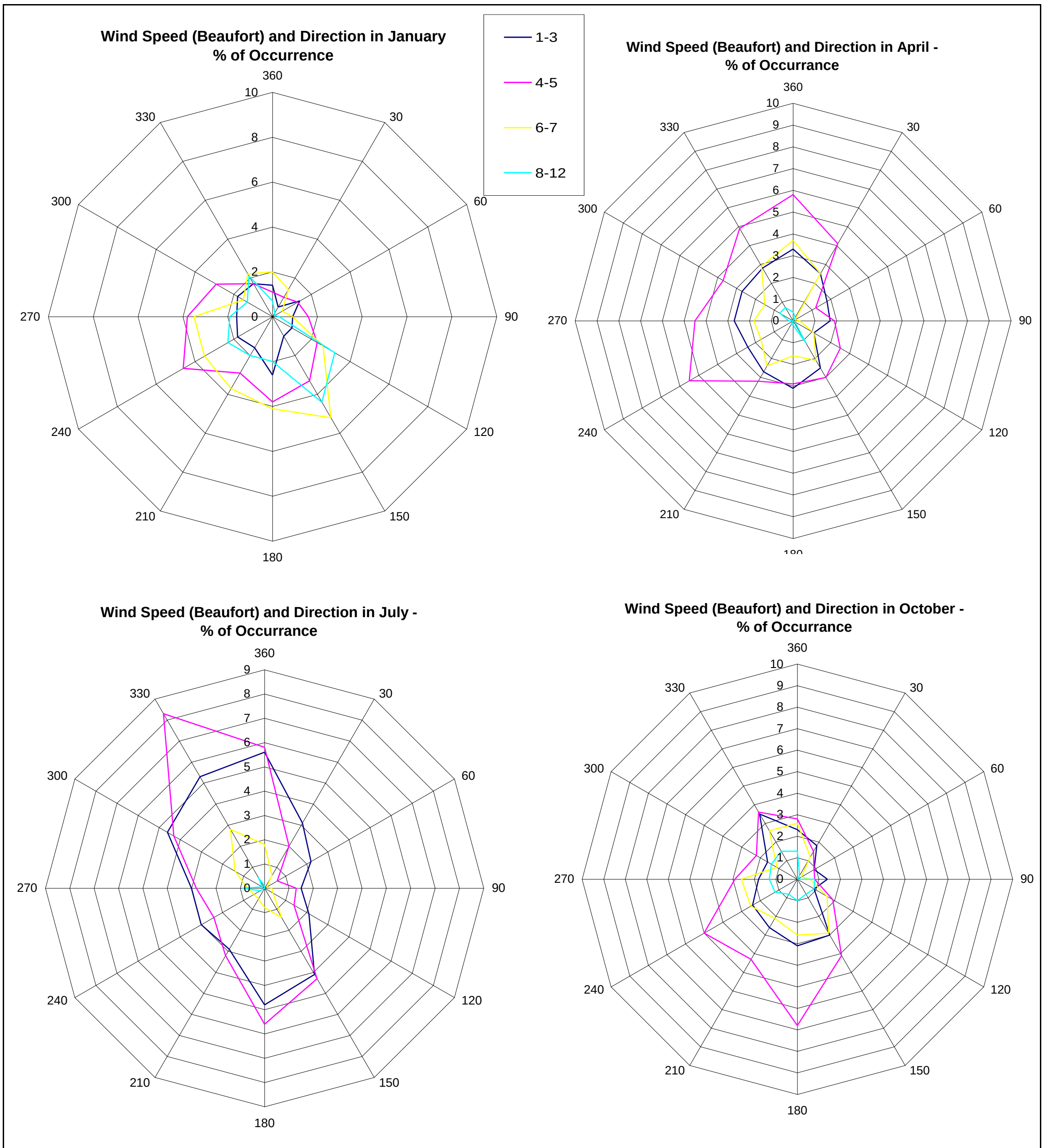


Figure 3.1: Schematic diagram of the general circulation in the North Sea

3.2.2 Meteorology

Wind directions are variable in this area of the North Sea, but predominantly blow from the south and south-west (Figure 3.2). Northerly winds occur most frequently during the spring and early summer. There is a marked seasonal variation with stronger winds prevailing during the autumn and winter. The maximum hourly mean wind speed, with an average recurrence of 50 years at ten metres above still water level, is between 37 and 38 m/s in this area (UKDMAP, 1998).



Source: Korevaar, 1990.

Figure 3.2: Wind roses for area 58.0° N to 59.9° N, 0.0° E to 1.9° E

3.2.3 Temperature and Salinity

Temperature and salinity conditions in the area define the tendency of the water column to stratify, and for thermocline formation. This results in different conditions at the surface and the bottom of the water column. Temperature is also important in determining the distribution and occurrence of marine organisms (Patin, 1999).

The seasonal variation in the sea temperature and salinity conditions in the area is provided in Table 3.2. Water temperature is relatively uniform throughout the water column during the winter months. Over the summer months, however, the increase in solar heat can result in a thermocline, which separates a warmer, less dense surface layer from a cooler, denser layer of water in the rest of the water column.

Table 3.2: Typical values of sea temperature and salinity

Season	Mean Temperature (˚C)		Mean Salinity	
	Sea Surface	Seabed	Sea Surface	Seabed
Winter	6.5 – 7	6.5 – 7	35.20 – 35.30	35.20
Summer	13.5 – 14	7 – 8	34.50 – 34.75	35.25

Source: UKDMAP, 1998.

Fluctuations in salinity are largely caused by the addition or removal of water through natural processes such as rainfall and evaporation. Salinity varies with season and changes in ocean currents.

3.2.4 Bathymetry

Water depth along the bundle route varies from 116.4 to 120 m (Lowest Astronomical Tide (LAT)), with the steepest gradient of 0.14˚ (Svitzer, 2001). The seabed gently shallows towards the south.

3.2.5 Seabed Sediments and Features

Seabed sediments which are composed of mineral and organic particles commonly occur in the form of mud, sand and gravel. The sediments are dispersed by processes driven by wind, tides and contrasts in water density. The nature of the sediments, and the amount of the sediment transport, can also provide information on the potential effects from the decommissioning activities, such as the extent of seabed disturbance or natural backfill. Seabed sediments also play an important role in the determination of the flora and fauna present. Whilst gravelly sediments are important to bottom-spawning fish species, muddy sediments are favoured by burrowing shellfish species such as Norway lobster (*Nephrops norvegicus*) (Rees *et al.*, 2007).

The distribution of seabed sediments within the northern North Sea results from a combination of hydrographic conditions, bathymetry and sediment supply (OSPAR, 2000). Broad scale sediment distribution maps indicate that the area of the Leadon Field is dominated by deep circalittoral sand with patches of deep circalittoral coarse sediment (Figure 3.4; JNCC, 2010a). Most of the sediments in the northern North Sea area are fine to coarse sands (Künitzer *et al*., 1992), with an approximate silt fraction of 5% and an organic fraction of 3% (Basford *et al*., 1989).

The environmental baseline survey showed that the seabed sediment at the Leadon Field to predominantly consist of poorly sorted very fine sands (Gardline Surveys, 2001).

The percentage of sediment fines (<63 µm) was consistently low throughout the survey area (Gardline Survey, 2001), ranging between 14.4% and 30.2% with negligible or no coarser material (> 2 mm). Slightly elevated levels of gravel were recorded around the Midline Structure, however, this was regarded as a natural phenomenon (Gardline Survey, 2001).

Sidescan sonar data retrieved from the 2001s pipeline route survey showed the seabed in the area to be of low reflectivity with very few features (Svitzer, 2001). The 2001 pipeline route data identified the sediments at the Leadon Field to be loose clayey sands, with occasional outcrops of firm to stiff clayey gravelly sands (Svitzer, 2001). Anchor scars were observed in the areas of firm to stiff clayey gravelly sand, but were not visible within the loose clayey sand sediments. This suggests the finer sediments in the development area are redistributed by seabed currents (Svitzer, 2001).

Small depressions were identified throughout the areas covered by the loose clayey sand, however, these were observed to be insignificant in depth (Svitzer, 2001). Underneath the surficial sandy sediments, firm to stiff clayey gravelly sands, up to 30m in thickness, predominate the shallow sediments in the development area (Svitzer, 2001).

3.3 Chemical Environment

Chemical analysis of the seabed provides an indication of the condition of seabed sediments in the area of the proposed project. Sediment chemistry is an important factor in ecological investigations, with areas of fine sediments acting as sinks which have the potential to release their contaminant load following disturbance.

The principal sources of hydrocarbons in the marine environment are anthropogenic (McDougall, 2000). However, contamination of the marine environment with crude oils is not a recent phenomenon, nor solely attributable to anthropogenic activities (Douglas *et al.*, 1981).

Owing to the complex and variable composition of oil in marine sediments, quantification of total hydrocarbons, groups of hydrocarbons and individual hydrocarbons are required to allow the identification of the source of oil within the sediments, be it anthropogenic, biogenic or geochemical. The results of the chemical analysis of the sediments around the Leadon Field are summarised in Table 3.3.

3.3.1 Total Hydrocarbons (THC)

Total hydrocarbons (THC) gives an indication of the total oil in the sediment, but does not indicate the source of contamination (UKOOA, 2006). THC concentrations recorded during the environmental baseline survey were considered representative of fine sandy sediments of the northern North Sea (Gardline Survey, 2001). THC concentrations recorded in the sediment samples ranged from 2.4 to 4.5 µg/g, which is well below the reported background concentrations found in the northern North Sea (Table 3.3; CEFAS, 2001a; UKOOA, 2006).

3.3.2 Polycyclic Aromatic Hydrocarbons (PAH)

Polycyclic aromatic hydrocarbons (PAHs) and their alkyl derivatives are ubiquitous in marine environments; however, sources of elevated PAHs in marine sediments are often associated with anthropogenic activities, particularly fossil fuel combustion (Neff, 2005).

Another source of PAHs is the use of oil-based muds during drilling operations and the subsequent discharge of these cuttings on the seabed (Breuer *et al*., 2004). This is no longer practised as the discharge of cuttings contaminated with more than 1% oil based fluids was eliminated under OSPAR Decision 2000/3 since 16 January 2001. The occurrence and concentration of PAHs in the environment is of concern since many possess mutagenic, carcinogenic or otherwise toxic properties (McDougall, 2000; Neff, 2005)

Total PAHs in the Leadon Field was found to range from 0.23 to 0.76 µg/g with a mean of 0.34 µg/g. These values fall within the reported background concentrations found in the northern North Sea sediments (Table 3.3; CEFAS, 2001b; UKOOA, 2006; OSPAR, 2005).

3.3.3 Alkanes

N-Alkanes are continuous, straight-chain alkanes, which are substantially more susceptible to weathering than their branched and ring-chain equivalents (pristane and phytane), and can provide valuable information to aid in the determination of hydrocarbon sources (Tran *et al*., 1995).

The n-alkane concentrations in the sediments of Leadon Field ranged from 0.49 to 2.74 µg/g, slightly elevated levels compared to background concentrations found in the northern North Sea sediments suggesting historical contamination from synthetic drilling muds (Table 3.3; UKOOA, 2006 and Gardline Surveys, 2001).

Table 3.3 Summary of sediment contamination status of the Leadon Field in comparison with northern North Sea background

Reference		THC	PCB	PAH	Total n-alkane	Ni	Cu	Zn	Cd	Hg	Ba	Cr	Pb	V
		(µg/g)	(µg/kg)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)	(µg/g)
Gardline Survey, 2001	*Min - Max*	*2.4-4.5*	-	*0.23-0.76*	*0.49-2.74*	*7-22*	*<5*	*<5-22*	*<1*	*0.01-0.02*	*349-1,050*	*13-29*	*8-14*	*7-19*
	Mean±SD	3.53±0.62	-	0.34±0.10	0.73±0.47	10.95±3.32	<5	8.04±5.35	<1	0.01	*499±186*	*19.3±4.62*	*10.2±1.8*	*13.3±3.3*
Reference concentrations (range or average)														
Estuaries [1]		-	6.8-19.1	0.2-28	-	-	-	-	-	-	-			
Coast [1]		-	2		-	-	-	-	-	-	-			
Offshore [1]		17-120	<1	0.2-2.7	-	9.5	3.96	20.87	0.43	0.16	-			
Oil & Gas Installations [1]		10-450	1,917	0.02-74.7	-	17.79	17.45	129.74	0.85	0.36	-			
UKOOA, 2006 [2]		10.82 (20.32)		0.123 (0.341)	0.40 (0.83)	10.86 (12.40)	3.57 (5.40)	12.14 (13.00)	0.23 (0.81)	0.04 (0.1)	332.38 (637.50)	17.14 (36.5)	7.0 (8.6)	12.14 (14.00)
OSPAR, 2005 [3]						30	20	90	0.2	0.05		60	25	
ND- not detected due to values below detection limits *Blank - no data*														

Source: (1) CEFAS, 2001b; (2) UKOOA, 2006; (3) OSPAR, 2005

3.3.4 Heavy and Trace Metal Concentrations

Many metals are generally persistent and most are toxic to varying degrees. Many essential metals such as copper (Cu), zinc (Zn) and chromium (Cr) are readily bio-accumulated, meaning that they are capable of causing lethal and sub-lethal toxic effects in benthic organisms even when found in apparently low amounts (Neff, 2005).

Metals typical of contamination of the sediment with drilling muds or cuttings are barium (Ba), Zn, Cr, and lead (Pb) (Neff, 2005). Ba and Zn have low bioavailability in marine sediments. The most abundant metal in most drilling muds is barium, found in the form of barite ($BaSO_4$). Generally, contamination by metals extends no further than 500m from production facilities, but elevated concentrations of Ba can be found from 500m to 1,000m (CEFAS, 2001). Monitoring sediment barium concentrations can provide information on the extent to which drill cuttings have been transported from their point of origin.

There was little variation in metal concentrations across the Leadon Field with exception of Ba which ranged from 349 to 1,050 µg/g (Table 3.3; Gardline Surveys, 2001). These concentrations were close to or above the reported concentrations reported around production facilities in the northern North Sea (Table 3.3; UKOOA, 2006), and consistent with sites previously identified as contaminated with petrogenic compounds of drilling related origin (Gardline Survey, 2001).

Heavy metal concentrations from the Leadon Field were within the background concentrations of the northern North Sea (Table 3.3; Gardline Surveys, 2001 and UKOOA, 2006).

3.4 Biological Environment

This section describes marine fauna and flora believed to exist within and around the Leadon Field.

3.4.1 Plankton

Plankton forms the primary basis of the marine food chain. The composition and abundance of plankton communities vary throughout the year and are influenced by physical parameters such as temperature, salinity and water inflow. In general, phytoplankton and the associated grazing zooplankton show a bimodal pattern of abundance throughout the year, with the main peak in late spring in response to the increasing photoperiod, and a second, smaller peak in late summer/ early autumn (Johns & Reid, 2001).

Within the vicinity of the Leadon Field the main spring increase in phytoplankton species occurs between mid-March and mid-April with a small autumnal peak occurring in September (Adams, 1987). The spring maximum of diatoms occurs in April while dinoflagellates peak in September, and are dominated by the *Ceratium* spp. (Reid *et al.*, 2003). The peak in zooplankton species occurs from late May to July and density decreases from October onwards. The zooplankton are dominated by the copepods, predominantly *Calanus* (Johns & Reid, 2001), as well as smaller species such as *Para-Pseudocalanus* and *Acartia* spp (DTI, 2001). Herbivores and smaller omnivores constitute about 80% of the standing stock of zooplankton throughout the year with the exception of winter and early spring.

Although natural seasonality is important as the plankton comprises different types and quantities of organisms at different times of the year, planktonic organisms are generally short lived and recovery following a pollution-induced population reduction is usually rapid.

3.4.2 Benthic Fauna

Benthic fauna comprises species which live either within the seabed sediment (infauna) or on its surface (epifauna). Activities that result in the physical or chemical disturbance of the seabed such as removal of infrastructures and pipeline decommissioning can impact these faunal communities.

During 1986, the whole of the North Sea was surveyed using standard techniques and equipment (Künitzer *et al.,* 1992; Basford *et al*., 1990) and the benthic infaunal assemblages were determined by depth and by sediment type. According to the benthic classification scheme of Künitzer *et al*. (1992), the Leadon Field falls within *category IIIb* (fine sediment deeper than 100 m), and would be expected to be characterised by a deep-water infaunal assemblage, which typically has high densities (2,863±1,844 individuals per m^{-2}) and species richness (51±13 species) (Künitzer *et al.,* 1992; NSTF, 1993).

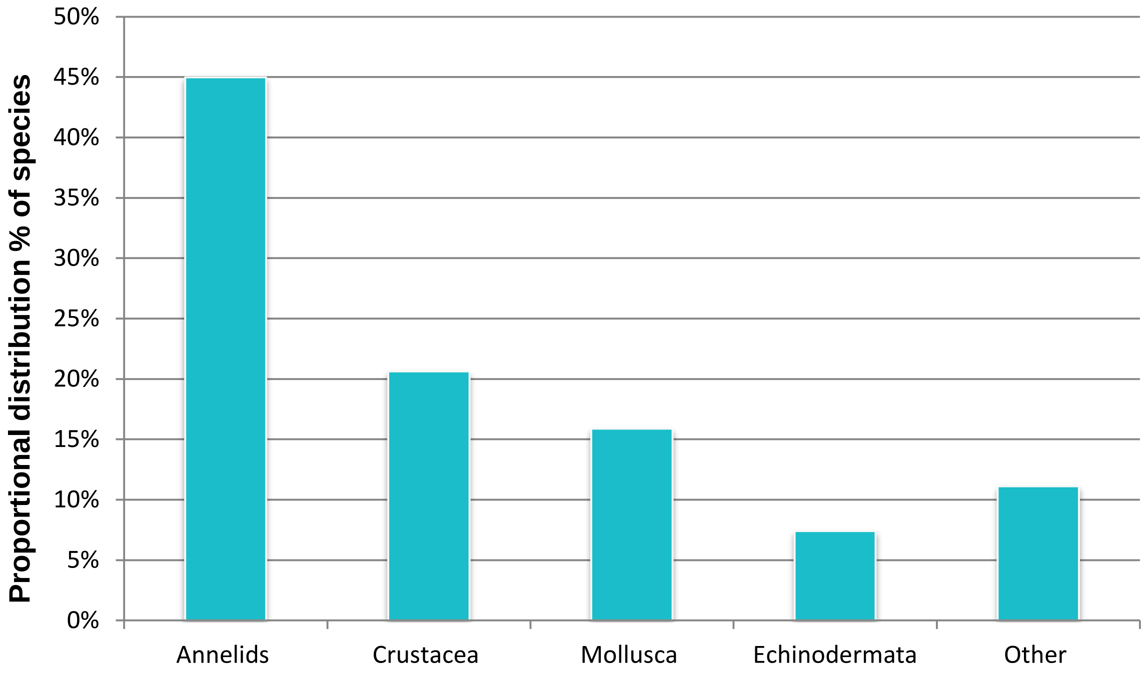
Indicator species of this benthic infaunal assemblage include the *Thyasira* spp. bivalve complex and the polychaetes *Minuspio cirrifera*, *Aricidea catherinae* and *Exogone verugera* (Künitzer *et al.,* 1992). Other indicator species found in the area's finer sediments were opportunistic bivalves from *Thyasira* spp., and on the coarser sediments the polychaetes *Ophelia borealis*, *Exogone hebes, Spiophanes bombyx* and *Polycirrus* spp. Species with restricted distribution almost exclusively in the northern North Sea are the brittlestar *Ophiura affinis* and the molluscs *Montacuta substriata* and *Antalis entails*.

The infaunal work was complemented by epifaunal studies in the same areas (Basford *et al.*, 1989, 1990). Epifauna species identified in the area include the starfish *Astropecten irregularis* (starfish) and *Asterias rubens* (common starfish), the yellow sea potato *Echinocardium flavescens*, *Brissopsis lyrifera* (sea urchin), the gastropods *Neptunea antique*, *Colus gracilis* and *Scaphander lignarius*, tunicates and sponges (Basford *et al.,* 1989).

Surveys conducted in the Leadon area found that the benthic community consisted of species typical of fine silty sand substrata and are chiefly surface and subsurface deposit feeders (Gardline Survey, 2001). Polychaete worms were observed to be the dominant taxa, while echinoderms, molluscs and crustacea were present in lower densities (Gardline Surveys, 2001). The number of macrofaunal species and their proportional distribution between the major taxa in the Leadon Field were as expected for the sediment type, depth and location. However, no epifaunal species were recorded across the survey area (Gardline Surveys, 2001).

Annelids were the most prevalent taxa identified in the survey, accounting for 45% of the total species. The remainder of the identified species were predominately comprised of crustaceans (20.6%), molluscs (15.9%), echinoderms (7.4%) (Figure 3.3; Gardline

Surveys, 2001). The most common species found at all stations were the polychaete *Spiophanes bombyx,* followed by *Paramphinome spp and Myriochele spp.*



Source: Gardline Surveys, 2001.

Figure 3.3 Macrofaunal composition in the Leadon Field area

The number of species and their proportional distribution between the major taxa were as expected for the sediment type, depth and location (Gardline Surveys, 2001). Faunal composition was observed to be fairly homogenous across the survey area, with variation related to weak sediment gradients (Gardline Surveys, 2001).

Surveys undertaken in the adjacent Block 9/13a (Beryl Field) between 1983 and 1991 identified that the sediments were dominated by the polychaetes *Capitella capitata*, *Owenia fusiformis*, *Paramphinome jeffrysii*, *Pseudopolydora paucibranchiata*, *Chaetozone setosa*, *Raphidrilus nemasoma* and *Pholoe inornata*, and the bivalve *Thyasira* spp. (UKBenthos, 2009).

Habitat Classification

Biotope types in the Leadon Field were classified according to the nature and distribution of the sediment found in the area, based on the European Union Nature Information Service (EUNIS) classification system (JNCC, 2010a) and are related to the most prevalent species abundance obtained from the survey data (Gardline Surveys, 2001). The dominant characteristic fauna were identified and matched by the EUNIS classification system to the most probable biotope rank, using the BioScribe database (JNCC, 2013). The most probable biotope identified within the location for the Leadon Field according to the EU system is EUNIS A5.27 (Figure 3.4), “deep circalittoral sand” which correspond to JNCC classification SS.SSa.OSa, “offshore circalittoral sand”

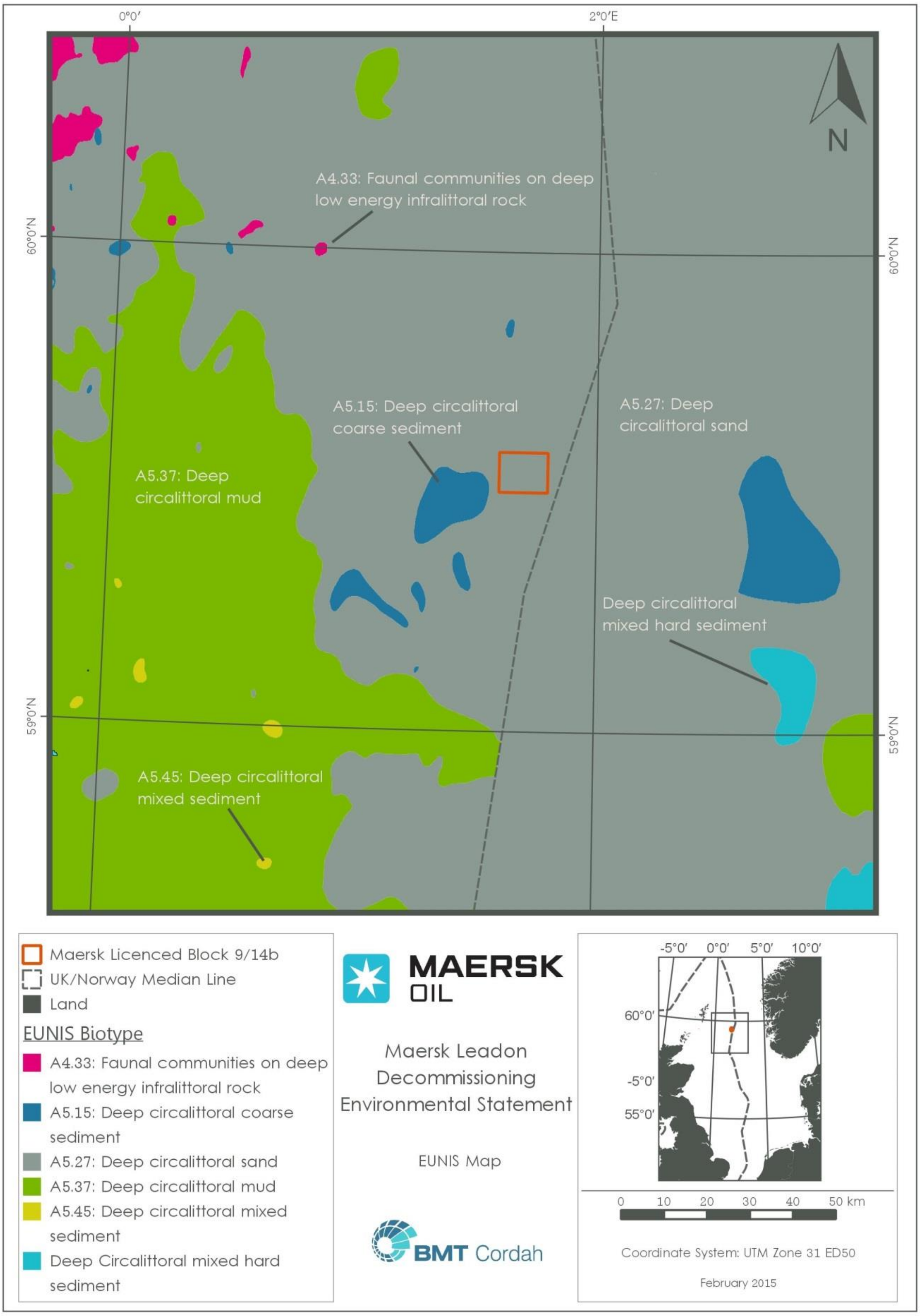
(Connor *et al*., 2004). However the predominant species composition and distribution identified during the environmental baseline survey (Gardline Surveys, 2001) could closely relate to EUNIS A5.443 *Mysella bidentata* and *Thyasira* spp in circalittoral muddy mixed sediment.

3.4.3 Fish and Shellfish

Generally, there is little interaction between fish species and offshore oil and gas developments. Some fish and shellfish species are, however, vulnerable to offshore oil and gas activities and associated discharges to sea (CEFAS, 2001a). The most vulnerable periods for fish species are the egg and juvenile stages. Fish that lay their eggs on the sediment (for example, herring and sandeels) or live in intimate contact with sediments (for example, sandeels and most shellfish) are susceptible to smothering by discharged solids. Other ecologically sensitive fish species include cod, most flatfish (including plaice and sole) and whiting because in the North Sea these stocks are considered to be outside 'safe biological limits' (European Environmental Agency, 2011).

The industry-commissioned Fisheries Sensitivity Maps in British Waters and Strategic Environmental Assessment (SEA) 2 Technical Report on North Sea Fish and Fisheries (CEFAS, 2001a; Coull *et al*., 1998), as well as the CEFAS led report on spawning and nursery areas of fish of commercial and conservation importance (Ellis *et al*., 2010); provide data illustrating fish spawning and nursery areas within the International Council for the Exploration of the Sea (ICES) rectangle 48F1, which coincides with the Leadon Field (Figure 3.5).

The Leadon Field lies within an area of high spawning intensity for Norway Pout (March to May) and a high nursery intensity nursery area for Blue whiting. The site sits in low intensity areas of spawning activity for cod (January to April), whiting (February to June), mackerel (May to August), and sandeels and a nursery activity area of low intensity for whiting, mackerel, sandeel, herring, anglerfish, and hake. The site is in an area of undetermined spawning intensity for haddock (February to May) and saithe (January to April) (Coull *et al.,* 1998; Ellis *et al.,* 2010).



Sources: DECC, 2013a; UK Oil and Gas Data, 2014; JNCC, 2010a

Figure 3.4: Biotope types at the Leadon Field location.

Sources: Coull et al., 1998; Ellis et al., 2010

Figure 3.5: Areas of importance for fish spawning and development in the Leadon Field Area.

3.4.4 Sharks, Rays and Skates (Chondrichthyes)

Chondrichthyans include sharks, rays and chimaeras, which have typically slow growth rates, late age at maturity and low reproductive output. They are generally considered to be vulnerable to human activities (for example, overfishing). These species require a suitable substratum for the deposition of their eggs together with a preference for a habitat which includes species such as sponges, bryozoans, hydroids and dead man's fingers (soft coral) (Ellis *et al*., 2004).

Work is underway for developing National Plans of Action for the conservation and management of sharks in UK waters (Fowler *et al*., 2004). The UK BAP (Biodiversity Action Plan) has identified several shark species for priority conservation including angel shark, spiny dogfish, undulate ray, sandy ray, tope shark, common skate and basking shark (JNCC, 2007).

The distribution of the chondrichthyans on the UKCS is not extensively documented. However it can be concluded from the available literature (Ellis *et al*., 2004) that the Leadon Field is located within an area where both the number and the relative abundance of chondrichthyan species is low compared to other areas in the North Sea (Ellis *et al*., 2004). The species recorded in the area include: spurdog (*Squalus acanthias*), lesser spotted dogfish (*Scyliorhisnus canicula*), nurse hound (*Scyliorhisnus stellaris*), starry ray (*Amblyraja radiata*) and cuckoo ray (*Leucoraja naevus*).

Nursery areas of these species typically tend to be in shallower coastal areas, with the exception of spurdog and cuckoo ray juveniles which can be found further offshore (Ellis *et al*., 2004). Available data suggest that there are areas of nursery activity for spurdog within ICES rectangle 48F1 (Ellis *et al*., 2010).

3.4.5 Seabirds

Seabird vulnerability to offshore surface pollution varies throughout the year with peaks in the late summer after breeding when the birds disperse across the wider North Sea area, and during the winter months with the arrival of over-wintering birds. To assess the relative risk for different species, the JNCC Seabirds at Sea Team (SAST) has developed an index to assess the vulnerability of bird species to the threat of oil pollution. This offshore vulnerability index (OVI) is derived by taking into account the following four factors (Williams *et al*., 1995):

amount of time spent on the water	**total biogeographic population**
reliance on the marine environment	**potential rate of recovery**

In general, offshore areas of the North Sea contain peak numbers of seabirds following the breeding season and through the winter, with birds tending to forage closer to coastal breeding colonies in spring and early summer. The breeding season extends from May to June with birds arriving at the coastal colonies on Shetland from March onwards and feeding in the inshore waters. In July the seabird densities in the region are highest when birds leave the coastal colonies to feed in the offshore waters. Of the species commonly present offshore in the North Sea; Gannet, skuas and auk species (Guillemot, Razorbill and Puffin) are considered to be the most vulnerable to oil pollution, since after the breeding period they undergo a complete post-breed moult during which they are flightless. At the end of July, seabirds begin to disperse to wintering grounds, either heading south to central North Sea or north to the shelf west of Shetland (DTI, 2001).

The seasonal vulnerability of the seabirds in the Leadon area (UKCS Blocks 9/13, 9/14, and their surroundings) is derived from the JNCC block-specific vulnerability data (JNCC, 1999) (Table 3.3). Overall bird vulnerability in the Leadon area is generally lowest during May and June, when most adult seabirds are present at coastal breeding colonies. Vulnerability increases from July onwards as the breeding season ends and the birds disperse from their breeding colonies, especially for auk species. Seabird vulnerability is very high in October and high in November and January, with seabirds returning to the offshore waters during the winter months (JNCC, 1999).

The northern North Sea offshore environment is characterised by peak densities of Fulmar (*Fulmarus glacialis*), Gannet (*Morus bassanus*), Herring Gull (*Larus argentatus*) and auk species during the winter months. Gannets, Razorbills (*Alca torda*), Puffins (*Fratercula arctica*) and Guillemots (*Cepphus grille*) are widely distributed over the summer period and terns make their passage over the area at this time (DTI, 2001). Kittiwakes (*Rissa tridactyla*) are present throughout the year.

The closest breeding colonies to Leadon Field are located 166 km north west on Shetland. Common seabird breeding colonies around Shetland include Fulmar, Gannet, Cormorant (*Phalacrocorax carbo*), Great Skua (*Catharacta skua*), Arctic Skua (*Stercorarius parasiticus*), Great Black-backed Gull (*Larus marinus*), Kittiwake, Common and Artic Tern, Razorbill, Puffin and Black Guillemot. Maersk will endeavour to undertake operations outside the main period of seabird vulnerability to limit risk to seabirds.

Table 3.3: Seabird vulnerability to oil pollution in Leadon and surrounding blocks

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
9/07	2	4	3	3	4	4	2	4	3	1	1	3
9/08	2	4	3	3	4	4	2	3	3	1	1	3
9/09	2	4		3	4	4	2	3	3	1	1	
9/10	2	4		3	4	4	2	3	3	1	1	
9/12	2	4	3	3	4	4	2	4	3	1	4	3
9/13	2	4	3	3	4	4	2	3	3	1	3	3
9/14	2			3	4	4	2	3	3	1	3	
9/15	2			3	4	4	2	3	3	1	2	
9/17	2	4	3	3	4	4	2	4	3	1	3	2
9/18	2	4	3	3	4	4	2	3	3	1	3	2
9/19	2		4	3	4	4	2	3	3	1	3	
9/20	2		4	3	4	4	2	3	3	1	2	

Key		
	1	Very high seabird vulnerability
	2	High seabird vulnerability
	3	Moderate vulnerability
	4	Low vulnerability
		No data
		Leadon Field area

Source: JNCC, 1999.

3.4.6 Marine Mammals

Marine mammals include whales, dolphins and porpoises (cetaceans), and seals (pinnipeds). They may be vulnerable to the effects of oil and gas activities and can be impacted by noise, contaminants, oil spills and any effects on prey availability (SMRU, 2001). The abundance and availability of prey, including plankton (Section 3.4.1) and fish (Section 3.4.3) can be of prime importance in determining the abundance and distribution of marine mammals and can also influence their reproductive success or failure. Changes in the availability of their principal prey species may be expected to result in population level changes of marine mammals but predictions of the extent of any such changes is considered to be challenging (SMRU, 2001).

Cetaceans

Cetaceans can be divided into two main categories: baleen whales (Mysticeti), which feed by sieving water through a series of baleen plates; and toothed whales (Odontoceti), which have teeth for prey capture. Cetaceans are widely distributed in UK waters and are recorded throughout the year (Reid *et al*., 2003).

In the Leadon area (UKCS Quadrant 9) and the surrounding Quadrants harbour porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*), minke whale (*Balaenoptera acutostrata*), Atlantic white-sided dolphin (*Lagenorhynchus acutus*) and white-beaked dolphin (*Lagenorhynchus albirostris*) have been recorded as present in the area, in low to very high densities (Reid *et al*., 2003; UKDMAP, 1998) (Table 3.4). Harbour porpoises have been recorded as present for most of the year, with very high densities in February and high densities in July and September, white-beaked dolphins have been recorded most of the year, in low to medium densities; and killer whales, minke whales and white-sided dolphins have also been sighted in low densities, mainly during the summer months (Reid *et al*., 2003; UKDMAP, 1998) (Table 3.4). Therefore, the most sensitive periods for marine mammals in the area are from February to March, from May to September and during November when the densities of marine mammals range from very high to moderate, with the exception of June, when densities are low.

Table 3.4: Seasonal cetacean sightings around Leadon area

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Harbour porpoise	L	VH		L	L	L	H	M	H			L
Minke whale							L	L				
White-beaked dolphin		M	M			L	L	L			M	
White-sided dolphin							L					
Killer whale					M						L	

Key		
		No animals/ No data
	L	Low densities (0.01 to 0.09 animals/km)
	M	Moderate densities (0.10 to 0.19 animals/km)
	H	High densities (0.20 to 0.49 animals/km)
	VH	Very high densities (>= 0.50 animals/km)
		Sightings within the proposed development Quadrant 3
		Sightings in the surrounding Quadrants

Source: Reid et al., 2003; UKDMAP, 1998.

Pinnipeds (seals)

Both grey (*Halichoerus grypus*) and common seals (*Phoca vitulina*) have breeding colonies on Orkney and Shetland, and can travel considerable distances from their haul-out sites on feeding trips (up to 60 km or more, but this is relatively rare) (Hammond *et al*., 2002; Harwood & Wilson, 2001). Grey and common seals are resident in UK waters and occur regularly over large parts of the North Sea (SMRU, 2001; Stone, 1997). Both species breed in the UK, with common seals pupping in June/ July and grey seals pupping between September and December. British populations of grey and common seals represent approximately 40% and 5% of the world populations of these species, respectively (SMRU, 2001).

Both species are found predominantly along the UK coastline but there are few data available on the offshore distribution and abundance of seals. Tracking of seals suggests they make feeding trips lasting two to three days, normally travelling less than 40 km from their haul-out sites, and with the animal ultimately returning to the same haul-out site from which it departed (SMRU, 2001). Grey seals may spend more time further offshore than common seals. The Leadon Field is located approximately 166 km to the east of the nearest UK coastline (Shetland) so it is unlikely that grey and common seals would be regularly found in its vicinity. Grey and common seals are listed in Annex II of the Habitats Directive (Section 3.5.2).

3.5 Offshore Conservation Areas

The European Commission (EC) Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the Habitats Directive), and the EC Directive 2009/147/EC on the Conservation of Wild Birds (the Birds Directive), are the main instruments of the European Union (EU) for safeguarding biodiversity.

These Directives provide for the protection of animal and plant species of European importance and the habitats which support them, particularly through the establishment of a network of protected sites. The Habitats Directive includes a requirement to establish a European network of important high-quality conservation sites that will make a significant contribution to conserving the habitat and species identified in Annex I and II of the Directive respectively. Habitat types and species listed in Annex I and II are those considered to be in most need of conservation at a European level (JNCC, 2014a; Johnston *et al*., 2002). The UK government, with guidance from JNCC and the Department of Environment, Food and Rural Affairs (DEFRA), has statutory jurisdiction under the EC Habitats Directive to propose offshore areas or species (based on the habitat types and species identified in Annex I and II) to be designated as Special Areas of Conservation (SACs).

Twenty offshore candidate SACs (cSACs) were submitted to the European Commission in 2012 (JNCC, 2014a). All but one site (Hatton Bank) is now designated as a Site of Community Importance (SCI), which are SACs adopted by the European Commission but not yet formally designated by the government of each country.

The Leadon Field is situated approximately 55 km north from the Braemar Pockmark SCI, 136 km from the Scanner Pockmark SCI and 117 km southeast from Pobie Bank Reef SCI (Figure 3.6).

In relation to UK offshore waters, relative to the EC Habitats Directive, three habitats from Annex I and four species from Annex II are under consideration for the identification of SACs in UK offshore waters (Table 3.5) (JNCC, 2014a; Johnston et al., 2002).

Table 3.5: Annex I habitats and Annex II species occurring in UK offshore waters

Annex I habitats considered for SAC selection in UK offshore waters	Species listed in Annex II known to occur in UK offshore waters
• **Sandbanks** which are slightly covered by seawater all the time • **Reefs** (bedrock, biogenic and stony) ○ Bedrock reefs – made from continuous outcroppings of bedrock which may be of various topographical shapes (e.g. pinnacles, offshore banks); ○ Stony reefs – these consist of aggregations of boulders and cobbles which may have some finer sediments in interstitial spaces (e.g. cobble and boulder reefs, iceberg ploughmarks); and ○ Biogenic reefs – formed by cold water corals (e.g. *Lophelia pertusa*) and the polychaete worm *Sabellaria spinulosa*. • **Submarine structures made by leaking gases**	**Grey seal** (*Halichoerus grypus*) **Common (Harbour) seal** (*Phoca vitulina*) **Bottlenose dolphin** (*Tursiops truncates*) **Harbour porpoise** (*Phocoena phocoena*)

Source: JNCC, 2014b; Johnston et al., 2002.

The Offshore Marine Conservation (Natural Habitats & c.) Regulations 2007 (Amended 2009) transpose the Habitats Directive and Birds Directive in the marine offshore area, from 12 to 200 nm from the UK coast. Under these regulations it is an offence to deliberately disturb any listed species while it is within its SAC/ SCI; capture, injure or kill any wild bird or any wild animal of a European Protected Species (EPS); and/ or significantly disturb any EPS, whether it is within a protected site or not, in such a way as to significantly affect the ability of any significant group of animals to survive, breed, rear or nurture their young or the local distribution or abundance of that species.

EPS include all species of cetaceans (whales, dolphins and porpoises), all species of marine turtles, the sturgeon (*Acipenser sturio*) and the otter (*Lutra lutra*) (JNCC, 2014a).

3.5.1 Annex I Habitats

Of the Annex I habitats listed in the Table 3.5, only “Submarine structures made by leaking gases” could potentially be found in the vicinity of the Leadon Field. During the Maersk bundle surveys, no evidence of Annex I habitats was observed directly along the bundle routes (Maersk, 2011; 2013).

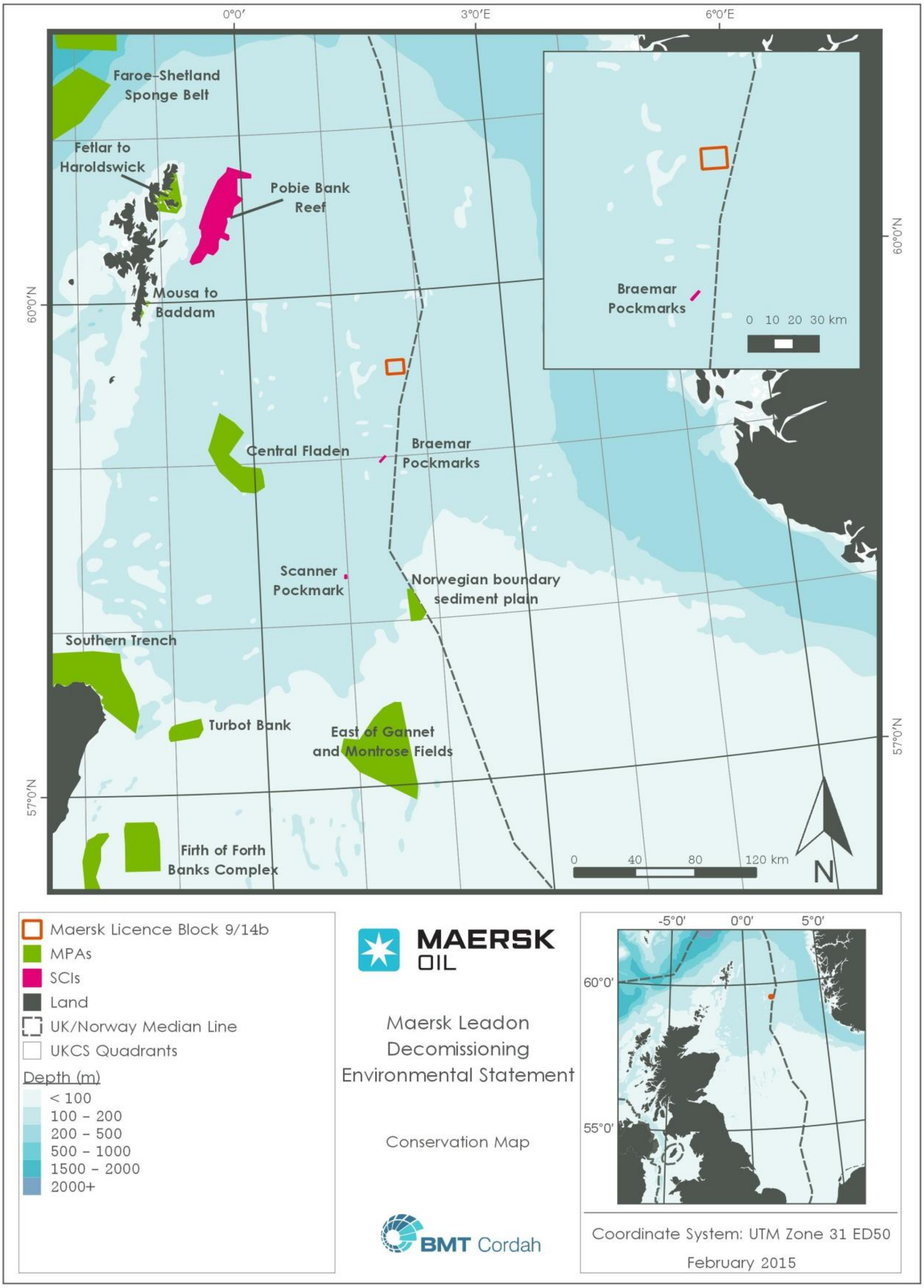
Submarine structures made by leaking gases

‘Submarine structures made by leaking gases’ in Annex I are defined as "spectacular sub-marine complex structures, consisting of rocks, pavements and pillars up to 4 m high”. These structures are formed by the aggregation of sandstone with carbonate cement which has resulted from the microbial oxidation of mainly methane gas emissions. The methane most likely originates from the microbial decomposition of fossil plant materials. The formations are interspersed with gas vents that intermittently release gas, and they shelter a highly diversified ecosystem with brightly coloured species" (EC, 2007).

Pockmarks are shallow seabed depressions generally formed in soft, fine-grained seabed sediments by the escape of fluids into the water column (Judd, 2001). Pockmarks alone are not considered to conform to any of the Annex I habitats, but the potentially important submarine structures listed in Annex I are often associated with gas seeps and pockmarks. Surveys and modelling studies have shown that the most readily pockmarked sediments are soft, silty muds (DTI, 2001).

The Leadon Field is located within the Witch Ground Formation in an area of potential gas seep. Data from the pipeline survey and baseline environmental survey did not reveal any evidence of pockmarks or Annex I habitat protected features in the Leadon Field area (Svitzer, 2001; Gardline Surveys, 2001).

The closest protected area containing these structures is the Braemar Pockmarks (SCI) in Block 16/3, which is located approximately 55 km from the proposed development (Figure 3.6). Based on previous studies the closest area of pockmarks is located in Block 9/19, 15 to 20 km south of the Leadon Field (DTI, 2001).



Source: DECC, 2013a; UK Oil and Gas Data, 20143; JNCC, 2014b.

Figure 3.6: Location of the Leadon Field in relation to offshore conservation areas.

3.5.2 Annex II Species

Annex II of the Habitats Directive lists species that are defined as species of community interest whose conservation requires the designation of Special Areas of Conservation (JNCC, 2014a). Four Annex II species are known to occur in UK waters (Table 3.5). As with all marine mammals, these four species can be impacted by a number of activities associated with the offshore oil and gas industry (Section 3.4.6) (DECC, 2009; SMRU, 2001).

Grey seal and common (harbour) seals

Seals from the Leadon area would be vulnerable to an oil spill. The potential and probable impacts are discussed in Section 11. For the characteristics of seals, refer to Section 3.4.6.

Bottlenose dolphins

There are two main areas within UK territorial waters where there are semi-resident groups of bottlenose dolphin (Cardigan Bay and the Moray Firth). Both sites have been designated as SACs for bottlenose dolphins. There are also smaller populations of dolphins off south Dorset, around Cornwall and in the Sound of Barra in the Outer Hebrides. Dolphins from all of these areas may occasionally move some distance from their apparent core range. Other dolphin groups, presumed to comprise of transients, are recorded further offshore in the deeper water to the west of Scotland (Evans, 2008).

In the North Sea, bottlenose dolphins are most frequently sighted within 10 km of land and they are rarely sighted outside coastal waters. For example, in the Moray Firth the population of dolphins is estimated to consist of approximately 129 individuals (95% confidence interval 110 to 174) (Wilson *et al*., 1997). Although these dolphins are considered to be resident in the inner Moray Firth, numbers decrease during the winter. Because sightings elsewhere around the coast do not increase accordingly, it is possible that animals from this population move offshore at this time of year (SMRU, 2001). Therefore it is possible that bottlenose dolphins may be present around the Leadon Field, although numbers are likely to be low and occurrence infrequent.

Harbour porpoises

The harbour porpoise is widespread throughout the cold and temperate seas of northwest Europe, including the North Sea, the Skagerrak, Kattegat, Irish Sea, the seas to the west of Ireland and Scotland, northwards to Orkney and Shetland and off the coasts of Norway (JNCC, 2010b). Harbour porpoises are highly mobile and well-distributed around the UK (Reid *et al.*, 2003). In the North Sea, sightings from shipboard and aerial surveys indicate that harbour porpoises are widely and almost continuously distributed, with important concentrations in the central North Sea, along the Danish and northern German coasts (Hammond *et al*., 2002; SCANS II, 2006). The seasonal movements and migratory patterns of harbour porpoises in the North East Atlantic and North Sea are not well understood. Porpoises may reside within an area for an extended period of time, but onshore/ offshore migrations and movements parallel to the shore are thought to occur (Bjørge & Tolley, 2002).

The UK Government examined distribution data for this species in inshore and offshore waters, and concluded that current conservation measures (including the UK-wide Small

Cetacean Bycatch Response Strategy and detailed guidelines covering seismic surveys, pile driving operations and the use of explosives) are sufficient to achieve the effective conservation of harbour porpoise. These measures focus on the reduction of threats/ impacts, such as fisheries by-catch and underwater noise, and wider surveillance (JNCC, 2010c).

Based on currently available data for Quadrant 9, which coincides with the Leadon Field, and surrounding quadrants, harbour porpoises have been observed throughout the year, with very high numbers recorded in February, and high numbers in July and September (Table 3.4) (UKDMAP, 1998). Although harbour porpoises may be present in the area throughout most the year, there appears to be a higher likelihood of their occurrence between April and September. The planned activities associated with the proposed Leadon decommissioning are scheduled to take a place throughout the year and would therefore coincide across the low to very high abundance ranges for the harbour porpoise in the area (Table 3.4).

3.5.3 Marine Protected Areas

In Scottish waters, under the Marine (Scotland) Act 2010, Scottish Natural Heritage (SNH), JNCC and Marine Scotland have started work on the identification of potential Nature Conservation Marine Protected Areas (MPAs) as part of the Scottish MPA Project. The Act includes new powers for Scottish Ministers to designate MPAs in the seas around Scotland as part of a range of measures to manage and protect Scotland's seas for current and future generations.

Both the Marine (Scotland) Act 2010 and the UK Marine and Coastal Access Act 2009 contain new powers to designate MPAs. Marine Conservation MPAs are intended to complement existing site-based measures by protecting nationally important marine habitats, species and features of geological/ geomorphological interest in the seas around Scotland not currently afforded protection through existing measures. The Scottish MPA network will therefore consist of European Marine Sites (for example, SACs and Special Protection Areas (SPAs)), the marine component of Sites of Special Scientific Interest (SSSIs), and the new Nature Conservation MPAs (Scottish Government, 2015).

The development of the Marine Protected Area (MPA) network is being undertaken in collaboration with marine stakeholders and during the last workshop held in July 2014, 33 MPA proposals were identified, out of 41 search locations considered by the Scottish Government (Scottish Government, 2015). No proposed MPA sites are situated within a 100 km proximity to the Leadon Field (Figure 3.6).

3.6 Coastal Conservation Areas

The south-eastern coast of the Shetland, located over 166 km from the Leadon Field, is of major conservation importance and contains many internationally protected sites. International designations found in this region include:

- SACs, cSACs and SCIs (EC Directive for the Conservation of Natural Habitats and Wild Flora and Fauna 1992)

- SPAs, protecting rare and vulnerable species of wild birds (EC Directive on the Conservation of Wild Birds, 1979)
- Ramsar and proposed Ramsar Sites (Internationally Important Wetlands of Importance, especially for Waterfowl, Ramsar, 1971)

A range of habitats including species-rich heathland, marshes and lochans, cliffs and rocky shores are found along the coastline of the Shetland. Several SPAs are located on the islands, notably Feltar, Noss, Fair Isle, Sumburgh Head and Mousa, the closest is located 155 km from the Leadon infrastructure. These sites are of importance for a number of northern breeding waders, as well as breeding seabirds, including skuas, terns, gulls and auks. Mousa is of importance as it has the largest colony of Storm Petrel (*Hydrobates pelagicus*) in Shetland.

The north-east Scottish coastline is located approximately 250 km to the south-west of the Leadon infrastructure. The shore along this coastline is a mixture of rocky platforms interspersed with low cliffs and boulder/ shingle beaches. Several SPAs are located on the east coast of Scotland, including Auskerry, Copinsay and the Pentland Firth Islands. These sites are important as a nesting area for a number of breeding seabirds (JNCC, 2014a).

A large number of nationally designated sites are also present, including numerous coastal SSSIs selected for geographical interest or for the presence of special plants, terrestrial invertebrates, breeding seabirds or breeding waterfowl. National Nature Reserves (NNRs) contain examples of some of the most important natural and semi-natural ecosystems in Britain including sand dune, shingle, saltmarsh, mudflat and wet grassland. Other sites of importance include a National Scenic Area (NSA), several sites owned by the Royal Society for the Protection of Birds (RSPB) and Scottish Wildlife Trust (SWT) sites, Areas of Outstanding Natural Beauty, Areas of Special Protection, Biosphere Reserves and Local Nature Reserves. In addition, there is a Marine Consultation Area off the Orkney Islands.

3.7 Socioeconomic Setting

This section focuses on the broader socioeconomic considerations of the existing baseline in relation to the Leadon decommissioning activities. Consideration is given to the potential impact on the fishing and shipping industries as well as any potential impact on other users of the sea, such as military activity and activity within the renewable energy sector. The existence of submarine cables, historic wrecks and other oil and gas installations are also considered.

3.7.1 Commercial Fisheries

An assessment of the fishing industry in the Leadon area has been derived from International Council for the Exploration of the Seas (ICES) fisheries statistics, provided by the Marine Scotland Science Division. Offshore oil and gas operations, including decommissioning activities, have the potential to interfere with fishing activities, for example as a result of the exclusion of fishing vessels from around an area of operation (CEFAS, 2001b). It is therefore important to have an understanding of the fishing activities and intensity in the Leadon area in order to evaluate the potential impacts associated with the proposed decommissioning activities on the fishing industry.

For management purposes, ICES collates fisheries information for individual rectangles measuring 30 nm by 30 nm. Data was obtained for ICES rectangle 48F1, which contains the Leadon infrastructure. Statistical data from the ICES rectangles provide information on the UK fishing effort and live weight of whitefish, pelagic and shellfish caught by all UK vessels between 2010 and 2013 and by foreign fishing vessels landed in UK (Marine Scotland, 2014).

Data on the economic value of the fishing industry in this area have been produced based on UK catches and landings (Marine Scotland, 2014). The overall value of different fisheries by area (financial yield per ICES rectangle) is an indication of the differential worth of areas and is used as a method of expressing commercial sensitivity (Coull *et al*., 1998).

The type of fishing gear and techniques employed by fishermen depends on a variety of factors, such as:

- species fished, e.g. whitefish, pelagic or shellfish;
- depth of water and seabed topography; and
- seabed characteristics.

Species found in the water column (pelagic species) are fished using techniques that do not interact with the seabed, whereas demersal and shellfish species are generally fished on or near the seabed. Both finfish, such as cod, whiting, haddock and flatfish, and shellfish species, such as *Nephrops* which are found on or near the bottom, are caught by whitefish gear methods. Demersal trawling methods interact with the seabed, and may interact with the existing infrastructure on the seabed and historical seabed anomalies created by oil and gas activities, including disturbance from subsea structures left in place such as footings, pipelines, rock placement or concrete mattresses left or buried in the sediment.

Fishing Value and Landings

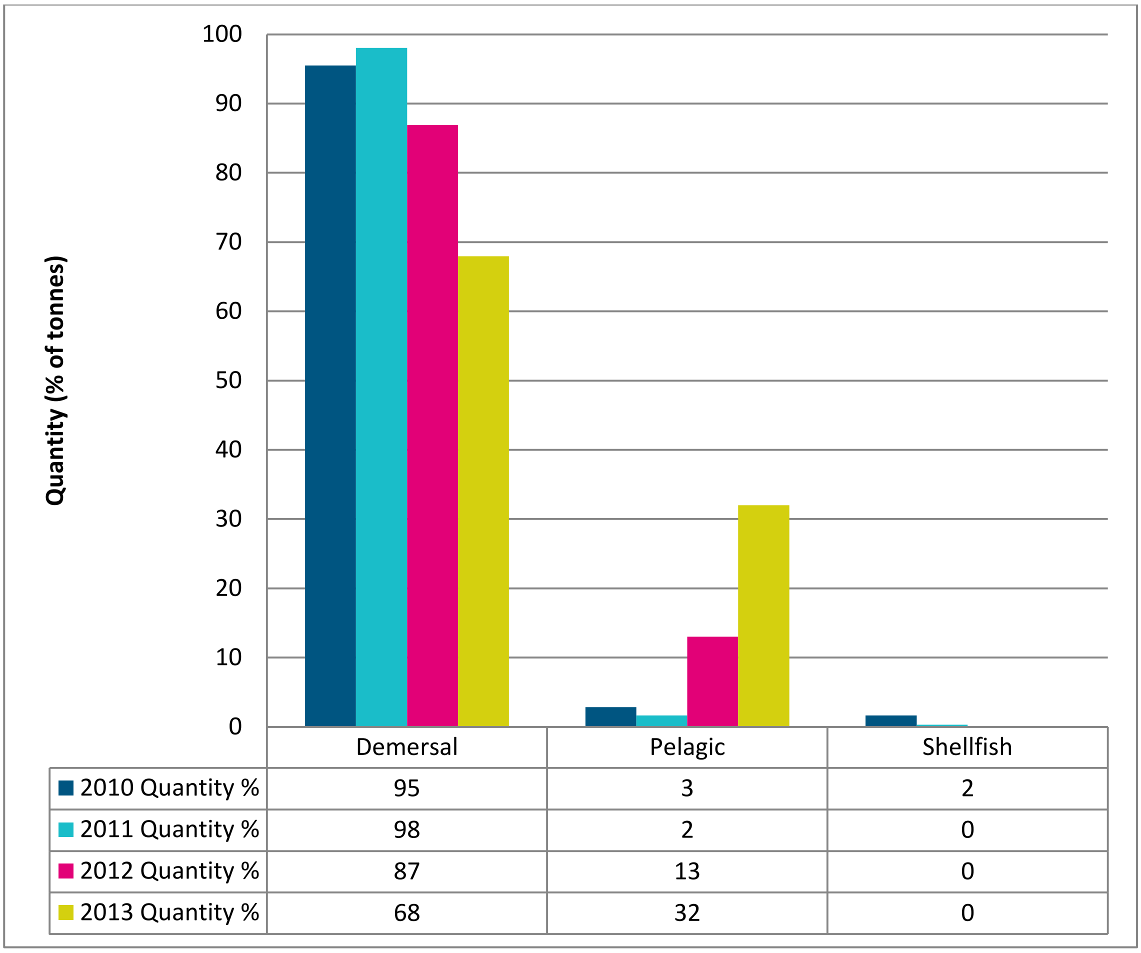
Between 2010 and 2013 the annual total live weight of fish landed from ICES rectangle 48F1 ranged from 1,222 tonnes in 2010 to 1,951 tonnes in 2013 (Marine Scotland, 2014). Relative to the rest of the UK, landings in 2013 are considered to be high for demersal species and very low for both pelagic and shellfish species (Table 3.6)

Table 3.6: Relative fishing landings of commercial fisheries in ICES rectangle 48F1

Landings in 2012	ICES Rectangle 48F1
Demersal	2,000 tonnes or greater (very high)
Pelagic	Under 2,000 tonnes (low)
Shellfish	Under 500 tonnes (low)

Source: Marine Scotland, 2014.

Demersal fishing methods, such as bottom pair trawling, otter trawling, otter twin trawling and Scottish seines dominated the fishing effort in ICES rectangle 48F1 between 2010 and 2013, accounting for 68% or more of the landings (Figure 3.7). Pair trawling gear was the most common method in ICES rectangles 48F1 comprising 63% of the total gear used in 2012. The latest data does not show detailed breakdown of gear type, but reports that in 2013, trawling gear was the dominant method in ICES rectangle 48F1 at 90% with seine nets comprising the remainder of the effort (Marine Scotland, 2014).

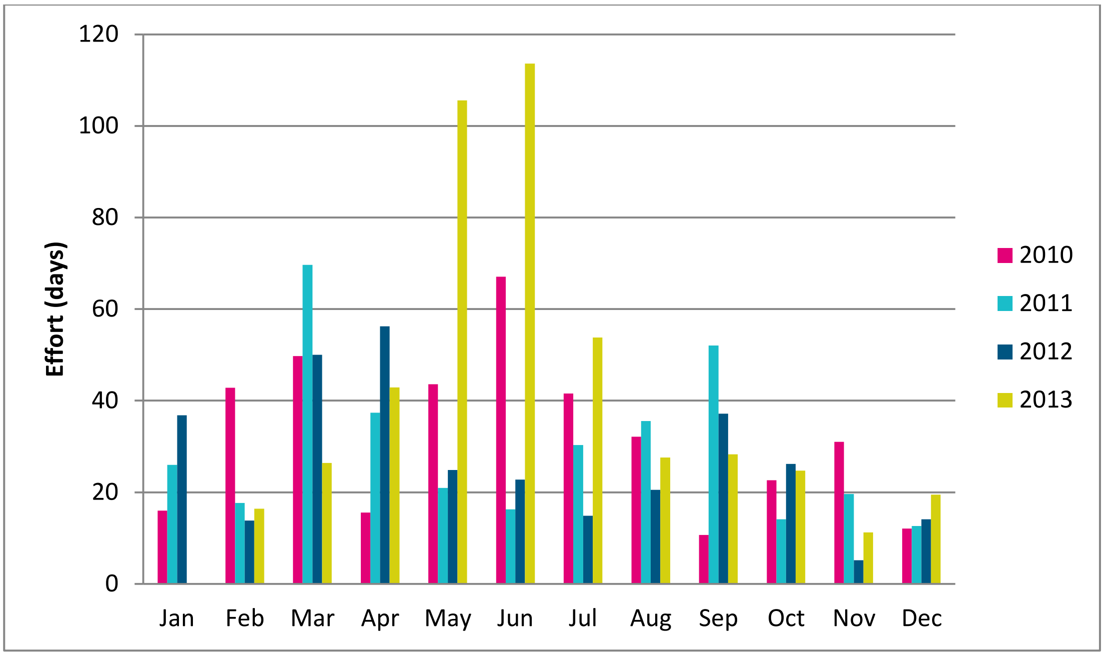


	Demersal	Pelagic	Shellfish
2010 Quantity %	95	3	2
2011 Quantity %	98	2	0
2012 Quantity %	87	13	0
2013 Quantity %	68	32	0

Source: Marine Scotland, 2014.

Figure 3.7: Fishery catch composition in ICES rectangle 48F1.

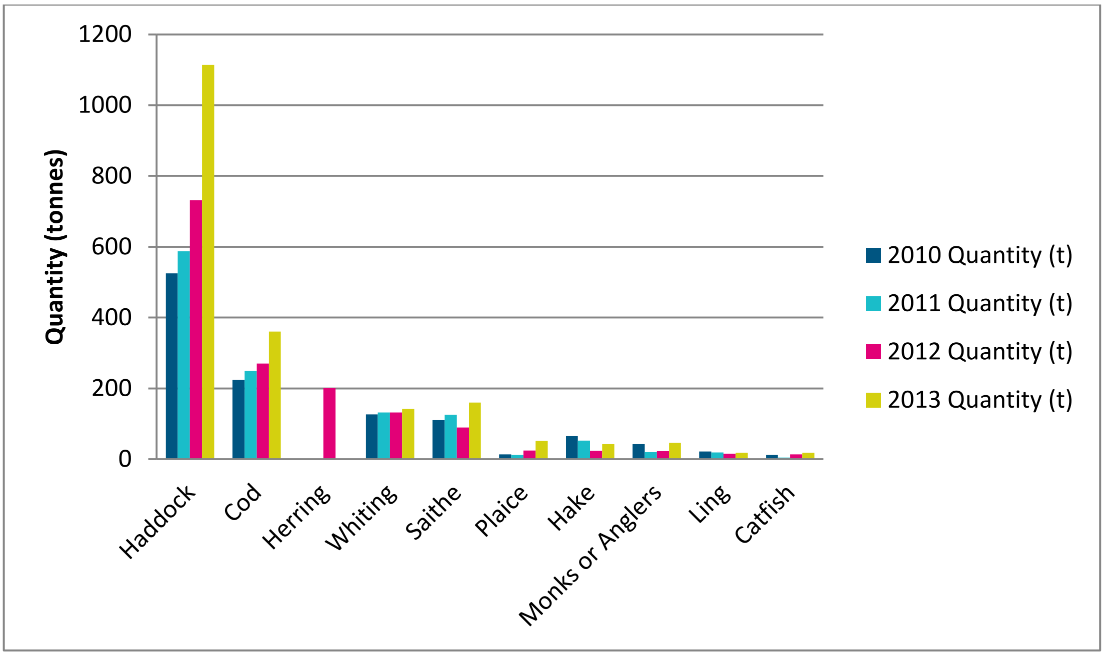
The monthly fisheries effort in ICES rectangle 48F1 is variable throughout the year with peak times in the summer months (Figure 3.8).



Source: Marine Scotland, 2014.

Figure 3.8: Fisheries effort by month for the period 2010 – 2013 in ICES rectangle 48F1.

Haddock dominated the catches between 2010 and 2013, making up 46 to 57% of total landings. Other species landed included cod, herring, whiting and saithe (Figure 3.9).



Source: Marine Scotland, 2014.

Figure 3.9: Catch composition by species in ICES rectangle 48F1.

Overall, the relative fisheries values in ICES rectangle 48F1 in 2013 were considered to be moderate for demersal species and low for pelagic and shellfish species compared to values in the rest of the UK (Table 3.7).

Table 3.7: Relative fishing value of commercial fisheries in ICES rectangle 48F1

Value 2013	ICES Rectangle 48F1
Demersal	$500,000 - £2,000,000 (moderate)
Pelagic	Under £2,000,000 (low)
Shellfish	Under $500,000 (low)

Source: Marine Scotland, 2014.

3.8 Shipping Traffic

The majority of shipping activity in the area is a result of fishing and oil related activities. Ships utilising the northern North Sea at long distances from any ports are unlikely to follow set shipping routes, so it is difficult to estimate the exact level of shipping intensity in this area. However, a shipping study carried out for the Leadon installation activities identified eight shipping routes within 1 nm of the field, with a combined annual traffic density of 587, corresponding to less than two vessels per day (Kerr McGee, 2000). DECC has classified the level of shipping density in Block 9/14 as very low (DECC, 2012).

3.9 Military Activity

Blocks 9/13 and 9/14 do not lie within a designated military exercise area (DECC, 2013a).

3.10 Nearby Oil and Gas Infrastructure

The Leadon infrastructure lies in Block 9/14 in an area of high oil and gas activity where 49 wells have been drilled, all by Maersk, the latest being suspended in 2006.

The 4" gas import flexible flowline (PL1895), which extends into Block 9/13, ties into the MLS at Leadon and runs to a valve structure within the Apache operated Beryl Alpha Platform's 500 m exclusion zone, 7.5 km to the west of Leadon. The gas import line is filled with hydrocarbon gas at ambient pressure and remains connected to the valve structure at Beryl Alpha. The flexible flowline crosses a number of pipelines within the Beryl Alpha 500 m zone (Table 3.8, Figure 3.10).

Table 3.8: Crossing details

Crossing Description	PL No.	Operator	Crossing	Easting	Northing
32" Oil to SPM3	PL381	Apache	Under	417 450	6 601 744
SS48 6" Gas Lift	PL354	Apache	Under	417 370	6 601 725
*Skene (NBR)	PL1840	Apache	Over	417 334	6 601 712
Skene Bundle	PL1840	Apache	Under	417 299	6 601 704
SS48 6" Flowline	PL353	Apache	Under	417 264	6 601 693
Buckland Bundle	PL1696	Apache	Under	417 246	6 601 689
SS48 Umbilical	N/A	Apache	Under	417 205	6 601 678

**The Skene NBR crosses over the 4" flexible flowline. Source: Maersk, 2013*

3.11 Wrecks

There are 1,157 confirmed and possible wrecks in the SEA2 area, with 69 in the Northern North Sea, 524 in the Central North Sea and 564 in the Southern North Sea. Forty-six wrecks off coast of UK are designated under the Protection of Wrecks Act 1973 (DTI, 2001), none of which are located in SEA2 area. One non-dangerous wreck, a ship sunk by torpedo in 1915, has been assumed to be located in the block of interest, however the exact position is unknown (Seazone, 2014). As it is not been discovered in the ROV surveys, it is assumed to not be in conflict with the bundle decommissioning efforts.

3.12 Dredging and Dumping Activity

No commercial or capital dredging is undertaken in the area, nor are there any sites licensed for disposal of dredged material within Blocks 9/13 or 9/14.

3.13 Tourism and Leisure

Blocks 9/13 and 9/14 do not lie within a sea area where tourism and leisure activities are prevalent.

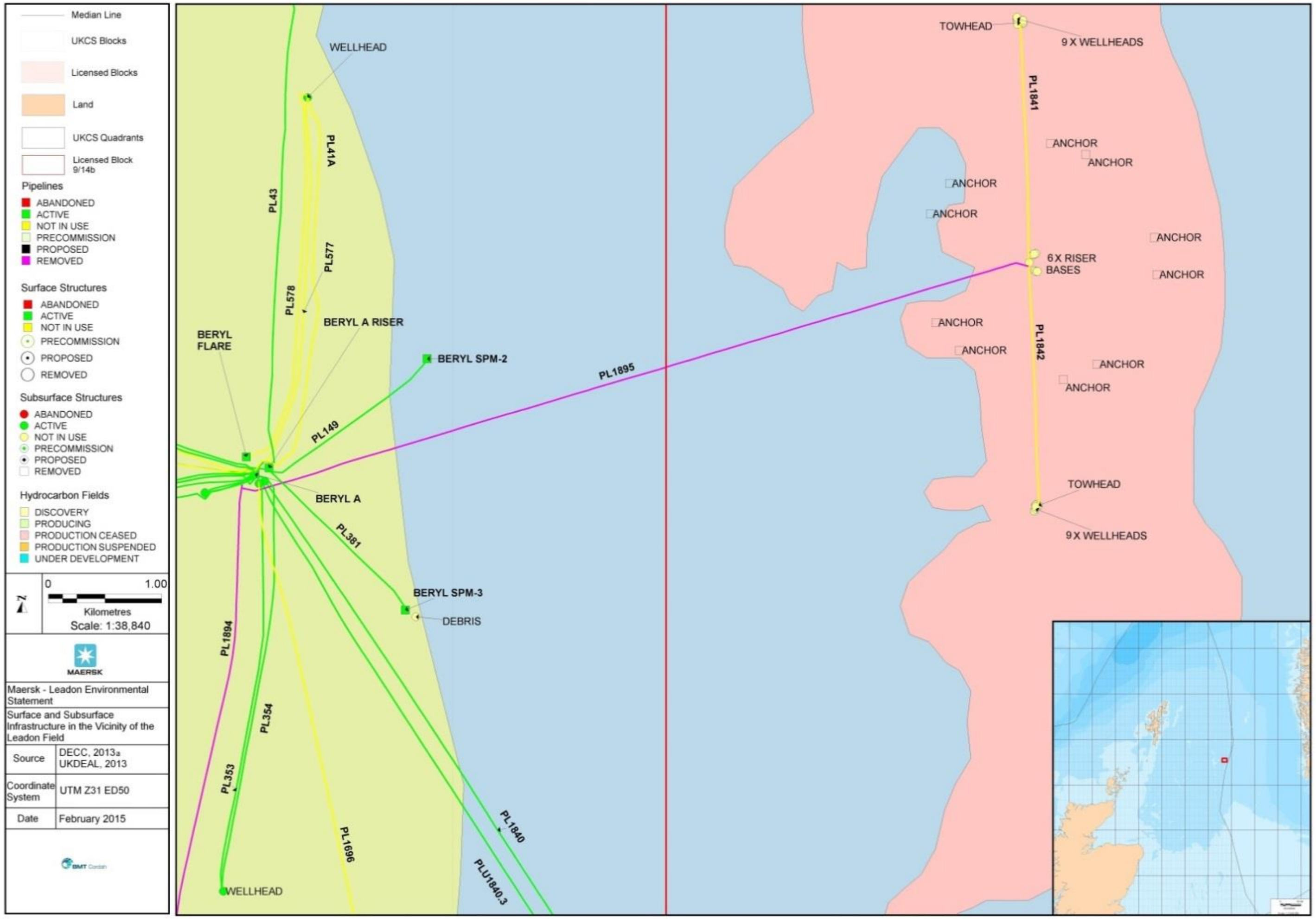


Figure 3.10: Oil and gas infrastructure in relation to the Leadon Field location.

3.14 Summary of Seasonal Environmental Sensitivities

A summary of the seasonal sensitivities for the Leadon area is presented in Table 3.9.

Table 3.9: Seasonal environmental sensitivities in the vicinity of the Leadon Field

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Habitats Directive: Annex I Habitats - There are no known Annex I habitats in the Leadon area (Gardline Surveys, 2001; Svitzer, 2001). Neither of the two Bundle integrity assessments showed evidence of Annex I habitats (Maersk, 2011; 2013).											
Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Habitats Directive: Annex II Species - Of the Annex II species, only the harbour porpoise has been sighted in the Leadon area, with very high abundance in February, high in July and September, medium numbers in August and low numbers in December, January, April, May and June (UKDMAP, 1998).											
Low	Very high	No data	Low	Low	Low	High	Moderate	High	No data	No data	Low
Benthic Fauna - Benthic communities in the Leadon area are similar to those found throughout a large surrounding area of the Northern North Sea. No rare species are known to occur in this area (Gardline Surveys, 2001).											
Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Plankton - The plankton in the Leadon area is typical of the Northern North Sea. Peak productivity occurs in spring and summer.											
Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Finfish and Shellfish - The Leadon Field lies within an area of high spawning intensity for Norway Pout (March to May) and a high nursery intensity nursery area for Blue whiting. The site sits in low intensity areas of spawning activity for cod (January to April), whiting (February to June), mackerel (May to August), and sandeels and a low intensity nursery area for whiting, mackerel, sandeel, herring, anglerfish, and hake (throughout the year). The site is in an area of undetermined spawning intensity for haddock (February to May) and saithe (January to April) (Coull *et al*., 1998; Ellis *et al*., 2010).											
High	High	High	High	High	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
Marine Mammals -Marine mammals sighted in and around the Leadon area include minke whales, killer whales, white-beaked dolphins, Atlantic white-sided dolphins and harbour porpoises. Peak sightings occur in the summer months (Reid *et al*., 2003; UKDMAP, 1998).											
Low	Very high	Moderate	Low	Moderate	Low	High	Moderate	High	No data	Moderate	Low
Seabirds - Seabird vulnerability to oil pollution in the Leadon area is "very high" in October, "high" in January, July, and November and "moderate" to "low" for the rest of the year. The overall vulnerability in the Leadon area is "moderate" (JNCC, 1999).											
High	Low	Moderate	Moderate	Moderate	Low	High	Moderate	Moderate	Very high	High	Moderate
Fisheries - Relative to the rest of the UK, the landings values in 2013 are considered to be high for demersal species and very low for both pelagic and shellfish species. Demersal species also dominated the landings, and their relative volume by tonnage was "very high" in 2013. Haddock dominated the catches between 2010 and 2013, making up 46 to 57% of total landings. Other species landed included cod, herring, whiting and saithe (Marine Scotland, 2014).											
Shipping - Shipping traffic in the vicinity of Leadon Field is of very low density, with less than two vessels per day (DECC, 2012).											
Oil and Gas – nearby surface infrastructure - The Leadon infrastructure lies in an area of high oil and gas activity. The 4" gas import flexible flowline (PL1895) ties into the MLS at the Leadon Field and runs to a valve structure within the Apache operated Beryl Alpha Platform 500 m zone, 7.5 km to the west of Leadon. The flexible flowline crosses a number of pipelines within the Beryl Alpha 500 m exclusion zone.											
Other users of the sea - There are no recorded wrecks in the vicinity of the Leadon Field (DTI, 2001). Blocks 9/13 and 9/14 do not lie within a designated military exercise area (DECC, 2012).											

Key Very high   High   Moderate   Low sensitivity   No data

Intentionally blank page

4.0 CONSULTATION

4.1 Initial consultation

The formal consultation process will begin with the resubmission of the consultation draft for the Decommissioning Programmes. There have been initial meetings and dialogue with the SFF with regards to the proposal options. The SFF have consulted with their membership on the proposed decommissioning strategy and their response is included in the initial submission of the Consultation Draft (Maersk, 2014).

The SFF's response to Maersk highlighted concerns regarding the use of rock dump. The long-term presence of the rock dump within fishing grounds and the potential safety issues associated with its presence were of particular concern, leading the SFF to recommend complete removal of the bundle and disposal onshore. SFF noted that given current removal techniques (and for reasons of safety and environmental concern), complete removal is not currently a viable option. Maersk will continue to mitigate against any risk to the commercial fishing fleet using established (trawler-friendly) rock dump techniques and undertaking immediate trawlability trials. If these trails fail, additional rock dumping will be conducted as soon as possible. Additionally, a guard vessel will remain on site until the field is considered safe for other sea users.

4.2 Future consultation

Further consultation and communication will be undertaken and followed up with the resubmission of the Consultation Draft. It is anticipated that the consultation process will include the Decommissioning Programmes placed on the Maersk website. In addition a copy of the Decommissioning Programmes will be available at Maersk's Aberdeen office for inspection by members of the public. As well as making the programmes publicly available, copies will be sent to the following statutory consultees for comment:

- SFF
- National Federation of Fishermen's Organisations (NFFO)
- Northern Ireland Fish Producer's Organisation (NIFPO)
- Global Marine Systems Ltd (GMS)
- Marine Scotland
- JNCC
- Maritime and Coastguard Agency (MCA)

The consultation period will last approximately 30 days, following which Maersk will be notified of any objection to the proposals.

Intentionally blank page

5.0 RISK ASSESSMENT

5.1 Introduction

Routine activities associated with hydrocarbon exploration and production, and unplanned events or situations that occasionally arise, may all affect the environment. As required under the Petroleum Act, 1998 and OSPAR Decision 98/3, this section identifies and ranks the environmental and socio-economic risks that could arise directly or indirectly from planned and unplanned activities associated with the decommissioning of the Leadon facilities.

The decommissioning of the Leadon facilities has the potential to cause environmental impact in several different ways, including physical disturbance of the seabed, emissions of gases to the atmosphere, discharges of liquids and contaminants to sea and the generation of wastes for disposal onshore. These effects could arise as a result of the operations or consequences in two broad aspects of the decommissioning programme:

1. Removal of the surface laid seabed infrastructures (including towheads, MLS, spools, mattresses, gas import flowline from Beryl Alpha and wellheads); and
2. Leaving the pipeline bundles in place.

An assessment was undertaken of the significance of the risks to any environmental compartment as a result of the operations (the activities that would be undertaken to complete the option) or the end-points (the final state of the facilities, materials or environment as a result of successfully completing the operation). The assessment also looked at both planned operations and accidental events. Hence, within these four aspects of the decommissioning programme, the activities have been broken down further into four sub-categories:

1. Planned operations.
2. Planned end-points.
3. Unplanned operations.
4. Unplanned end-points.

5.2 Risk Assessment Methodology

The purpose of the risk assessment process is to identify those potential impacts and risks that may be significant in terms of the threat that they pose to particular environmental receptors, the need for measures to manage the risk in line with industry best practice and the requirement to address concerns or issues raised by stakeholders during the consultation for this ES.

In this section of the ES, the scope of the risk assessment is confined entirely to the decommissioning of the Leadon facilities. Tables 5.6 and 5.7 show the outcomes of this assessment and Chapters 6 to 11 provide a more detailed evaluation of those impacts and risks that were assessed as likely to be significant. Appendix B provides a justification for those risks that were deemed to present a low risk

5.2.1 Overview of the assessment process

The risk assessment for the planned activities was derived by reducing the definition to:

Likelihood that an event will have an impact upon a particular environmental receptor	x	Magnitude of the effect	=	Significance of the impact/ risk

For planned events, it is certain that the event will occur; therefore, the first term can be set as equal to A (Definite) and can effectively be ignored. The primary driver for the risk assessment is then the 'Magnitude' that a planned activity has on a particular environmental receptor. This is governed by the receptor's sensitivity to the causes of impact, its location in relation to the source of the impact, the timing of the impact and the ability of the receptor to recover.

The definitions for "the likelihood of occurrence of the impact upon a particular receptor" and the "magnitude/ consequence of the environmental impact" for each activity are presented in Tables 5.1 and 5.2, respectively.

Table 5.1: Guidelines for assessing likelihood of occurrence of an impact upon a particular receptor resulting from the planned activities

Decreasing likelihood	Likelihood		Frequency of planned activity impacting receptors during project lifetime
	A	Definite	Impact observed every time
	B	Likely	Impact often observed
	C	Possible	Impact occasionally observed
	D	Unlikely	Impact rarely observed
	E	Remote	Impact almost never observed

Table 5.2: Guidelines for assessing the magnitude/ consequence of the impacts on the environment

Magnitude / consequence		Characteristics
5	Catastrophic	Adverse permanent impacts on key ecosystem functions in larger natural habitats or social and economic resources/ assets, uses or activities. Scale typically widespread (national or greater level).
4	Severe	Adverse long term impact on ecologically valuable natural habitats (e.g. restitution time >10 years), or social and economic resources/ assets, uses or activities. Scale typically regional to national level.
3	Major	Adverse medium term impacts on a significant part of habitats (e.g. restitution time 1 to 10 years) or social and economic resources/ assets, uses or activities. Scale typically local to regional level.
2	Moderate	Adverse short term impact on natural habitats, social and economic activities or resources, or social and economic resources/assets, uses or activities. Scale typically localised.
1	Minor	Very limited adverse impact on natural habitats or social and economic resources/assets, uses or activities. No impact on population, only on individual level. Typically transient and highly localised.

These factors were combined using a risk assessment matrix (Table 5.3) to determine what level of risk the proposed activity could pose to groups of receptors (or related attributes such as use of resources, use of disposal facilities, integrity of conservation sites, etc) in the physical, chemical, biological and socioeconomic receiving environments. The overall significance for a particular activity was determined by taking the highest level of risk associated with the project activity against any one of these receptors/ attributes.

Table 5.3: Environmental risk assessment matrix

		Planned	Unplanned/ Accidental	Magnitude/ consequence of impact (Table 2)					
				0 Beneficial	1 Minor	2 Moderate	3 Major	4 Severe	5 Catastrophic
Likelihood of occurrence (Table 1)	A	Definite	Likely	Beneficial A0	Low A1	Medium A2	Medium A3	High A4	High A5
	B	Likely	Unlikely	Beneficial B0	Low B1	Medium B2	Medium B3	High B4	High B5
	C	Possible	Very unlikely	Beneficial C0	Low C1	Low C2	Medium C3	High C4	High C5
	D	Unlikely	Extremely unlikely	Beneficial D0	Negligible D1	Low D2	Low D3	Medium D4	Medium D5
	E	Remote	Almost unheard of	Beneficial E0	Negligible E1	Negligible E2	Low E3	Low E4	Medium E5

5.2.2 Assessment of unplanned/ accidental events

Assessment for unplanned / accidental events is derived by reducing the definition to:

Likelihood that an event will occur	**X**	**Magnitude of the effect**	**=**	**Significance of the Impact/ risk**

The assessment is focussed, therefore, on the magnitude of any impact and the probability that the causal event will occur. As with Section 5.2.1, the magnitude of impact was assessed for each receptor and recorded in the tables.

The definitions for “the likelihood of occurrence of the unplanned or accidental event” and “the magnitude/ consequence of the environmental effects” for each activity are provided in Tables 5.2 and 5.4, respectively.

Table 5.4: Guidelines for assessing likelihood of occurrence of an impact resulting from unplanned/ accidental activities

	Likelihood		Frequency of an unplanned or accidental event occurring and impacting receptors during project lifetime
Decreasing likelihood	A	Likely	Might happen once a year; 1 per year
	B	Unlikely	Could happen several times; 1 per 10 years
	C	Very unlikely	Might happen; 1 per 100 years
	D	Extremely unlikely	Has occurred several times in industry; 1 per 1,000 years
	E	Almost unheard of	Few if any events in industry; 1 per 10,000 years

These factors were combined using a risk assessment matrix (Table 5.3) to determine what level of risk the proposed activity could pose to the physical, chemical, biological and socioeconomic receiving environments. The overall significance for a particular activity was determined by taking the highest magnitude of impact associated with the project activity (Table 5.2) against any one receptor/ attributes of the receiving environment and compared with the likelihood of the causal event from Table 5.4.

5.3 Risk Assessment Findings

The results of the risk assessment are shown in Tables 5.5 and 5.6. The left-hand column of the tables identifies the aspects of the project that will definitely cause or have the potential to cause impacts to sensitive receptors. These environmental aspects (BSI, 2004; BSI, 1996) include routine, abnormal and emergency events during the lifetime of the decommissioning project. The remaining columns of the tables identify the potential physical, chemical, biological and socioeconomic receptors. The four right-hand columns of the tables present the stakeholder concerns, the overall assessment of significance (i.e., the highest assessed risk) and the sections of the report that give a detailed justification of the assessment made.

The totals for “low” and “medium” environmental and socioeconomic risks associated with each activity are presented in Table 5.7. For impacts or risks that were considered to be “low”, Appendix B provides the justification for the assessment made and for excluding these impacts and risks from further investigation in the EIA.

Taking the effects of planned mitigation into account, no “high” environmental risks have been identified during the assessment. The risk assessment, however, did identify the following activities associated with the Leadon facilities as having the potential to be of “medium” risk and which are assessed further in chapters 6 to 10.

- Seabed disturbance (Chapter 6)
- Physical presence (Chapter 7)
- Discharges to sea (Chapter 8)
- Noise generation (Chapter 9)
- Atmospheric emissions and energy use (Chapter 10)

In addition, the potential for accidental hydrocarbon spillage is discussed in relation to the following scenarios, which are also considered as being of likely significance to the environment:

- Accidental events (Chapter 11)

Table 5.5: Sources of potential environmental impacts associated with decommissioning the Leadon facilities: Removal of surface laid seabed

1. Surface laid seabed infrastructures: • Towheads (2) • MLS • Spools and mattresses • Wellheads • Gas import flowline from Beryl Alpha ** Cumulative effect possible*	Physical and Chemical					Biological								Socioeconomic						Stakeholder concerns	Overall Significance	Justification Section Reference
	Sediment structure/ chemistry	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Integrity of conservation sites	Terrestrial flora	Terrestrial fauna	Commercial fishing	Shipping	Other commercial users of the sea	Recreational users of the sea	Communities	Other commercial users of the land			
Planned Operations																						
Physical presence of vessels														✓	✓	✓	✓				A1*	Chapter 7
Routine discharges and emissions from vessel spread		✓	✓*				✓	✓	✓	✓											A1*	Chapter 8/10
Underwater noise from vessels								✓	✓												A1*	Chapter 9
Underwater noise from operations								✓	✓												A1*	Chapter 9
Unlatch towheads and MLS	✓	✓				✓		✓													A1	Appendix B
Retrieval of towheads and MLS to vessel														✓	✓	✓	✓				A1	Appendix B
Physical removal of spools, mattresses and wellheads	✓	✓				✓		✓													A2	Chapter 6
Removal of gas import flowline from Beryl Alpha	✓	✓				✓		✓													A1	Appendix B
Retrieval of spools, mattresses and wellheads to surface														✓	✓	✓	✓				A1	Appendix B

1. Surface laid seabed infrastructures: • Towheads (2) • MLS • Spools and mattresses • Wellheads • Gas import flowline from Beryl Alpha ** Cumulative effect possible*	Physical and Chemical					Biological								Socioeconomic								
	Sediment structure/ chemistry	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Integrity of conservation sites	Terrestrial flora	Terrestrial fauna	Commercial fishing	Shipping	Other commercial users of the sea	Recreational users of the sea	Communities	Other commercial users of the land	Stakeholder concerns	Overall Significance	Justification Section Reference
Retrieval of gas import flowline from Beryl Alpha to surface														✓	✓	✓	✓				A1	Appendix B
Transport retrieved material to shore			✓*											✓	✓	✓	✓				A1*	Chapter 10
Transport retrieved material on land			✓*															✓	✓		A1*	Chapter 10
Treatment or recycling of material			✓*															✓	✓		A1*	Chapter 12
Planned End-Points																						
Re-use or recycling of towheads, MLS, and spools			✓*															✓	✓		A1*	Chapter 12
Mattresses not re-used or recycled go to landfill				✓	✓													✓*	✓*		A1*	Chapter 12
Unplanned Operations																						
Unrecovered large debris or dropped objects remain on the seabed	✓	✓												✓		✓					C1	Appendix B
Loss of contaminated water during operations	✓	✓						✓	✓												B1	Appendix B
Routine discharges and emissions from additional vessels		✓	✓*				✓	✓	✓	✓											C2	Chapter 8/10

1. Surface laid seabed infrastructures: • Towheads (2) • MLS • Spools and mattresses • Wellheads • Gas import flowline from Beryl Alpha ** Cumulative effect possible*	Physical and Chemical					Biological								Socioeconomic								
	Sediment structure/ chemistry	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Integrity of conservation sites	Terrestrial flora	Terrestrial fauna	Commercial fishing	Shipping	Other commercial users of the sea	Recreational users of the sea	Communities	Other commercial users of the land	Stakeholder concerns	Overall Significance	Justification Section Reference
Oil spill due to vessel collision		✓		✓			✓	✓	✓	✓				✓	✓	✓	✓	✓	✓		C3	Chapter 11
Spillage of chemicals		✓				✓	✓	✓	✓	✓											B1	Appendix B

Table 5.6: Sources of potential environmental impacts associated with decommissioning the Leadon facilities: Leaving pipeline bundles in place

Leaving the pipeline bundles *in place* (Full rock dump) ** Cumulative effect possible*	**Physical and Chemical**					**Biological**								**Socioeconomic**								
	Sediment structure / chemistry	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Integrity of conservation sites	Terrestrial Flora	Terrestrial Fauna	Commercial fishing	Shipping	Other commercial users of the sea	Recreational users of the sea	Communities	Other commercial users of the land	Stakeholder concerns	Overall Significance	Justification Section Reference
Planned Operations																						
Physical presence of vessels														✓	✓	✓	✓				A1*	Chapter 7
Routine discharges and emissions from vessel spread		✓	✓*				✓	✓	✓	✓											A1*	Chapter 8/10
Underwater noise from vessels									✓	✓											A1*	Chapter 9
Underwater noise from operations									✓	✓											A1*	Chapter 9
Offshore transportation of rock dump to site			✓*											✓	✓	✓	✓				A1*	Chapter 10
Mattress relocation to protect bundle ends	✓	✓				✓		✓													A2	Chapter 6
Burial of whole length of pipeline bundle by rock dump	✓	✓				✓	✓	✓	✓												A3	Chapter 6

Leaving the pipeline bundles in place (Full rock dump) ** Cumulative effect*	**Physical and Chemical**					**Biological**								**Socioeconomic**								
	Sediment structure / chemistry	Water quality	Air quality (local)	Land	Fresh-water	Sediment biology (benthos)	Water column (plankton)	Finfish and shellfish	Sea mammals	Seabirds	Integrity of conservation sites	Terrestrial Flora	Terrestrial Fauna	Commercial fishing	Shipping	Other commercial users of the sea	Recreational users of the sea	Communities	Other commercial users of the land	Stakeholder concerns	Overall Significance	Justification Section Reference
Planned End-points																						
Corrosion of pipelines and release of metals and pipeline contents	✓	✓				✓	✓	✓													A1	Appendix B
Long term physical presence of buried pipeline bundles	✓					✓								✓							A2	Chapter 7
Post-decommissioning vessel usage and subsea investigations during monitoring surveys		✓	✓*			✓	✓	✓	✓	✓				✓	✓	✓	✓				A1	Chapter 7
Unplanned End-points																						
Pipeline bundles not fully buried/ exposed as a result of fishing activity														✓						SFF	E4	Appendix B

Table 5.7: Summary of the risk assessment conducted for the decommissioning of the Leadon facilities

Project Stage	Risk																			
	Beneficial				Negligible				Low				Medium				High			
	Planned Operations	Planned End-points	Unplanned Operations	Unplanned End-points	Planned Operations	Planned End-points	Unplanned Operations	Unplanned End-points	Planned operations	Planned End-points	Unplanned Operations	Unplanned End-points	Planned Operations	Planned End-points	Unplanned Operations	Unplanned End-points	Planned Operations	Planned End-points	Unplanned Operations	Unplanned End-points
Removal of surface laid seabed infrastructures	0	0	0	0	0	0	0	0	12	2	4	0	1	0	1	0	0	0	0	0
Leaving the buried pipeline bundles *in place*	0	0	0	0	0	0	0	0	5	2	0	1	2	1	0	0	0	0	0	0
TOTAL	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**17**	**4**	**4**	**1**	**3**	**1**	**1**	**0**	**0**	**0**	**0**	**0**

6.0 SEABED DISTURBANCE

This section discusses potential short and long-term environmental impacts associated with seabed disturbance during the decommissioning of the Leadon infrastructure.

This assessment takes into account the biological environment that surrounds the Leadon Decommissioning area. Main considerations are the short and long-term effects on the seabed fauna and sediments from the decommissioning activities. The present assessment is supported by a study commissioned by Maersk to assess the impacts associated with seabed disturbance, including drill cuttings disturbance and dropped objects potentially resulting from the decommissioning activities (ERT, 2008).

6.1 Approach

An assessment of the potential short-term environmental impacts, associated with seabed disturbance during the decommissioning of the Leadon infrastructure, include:

- Removal of the North and South Towheads and MLS;
- Removal of six gravity riser base structures;
- Removal of the spoolpieces and jumpers;
- Rock dumping on the pipeline bundles;
- Removal of the gas import flowline;
- Removal of the concrete mattresses and grout bags;
- Use of baskets for speed loading grout bags and mattresses; and
- Potential for objects to be dropped during operations.

In addition, decommissioning the bundle in place may lead to some long-term impacts arising from:

- Physical presence of rock dump covering the bundle (habitat change); and
- Corrosion and eventual collapse of the bundle.

The magnitude of impacts arising from these activities and outcomes are described in the following sections.

6.2 Sources of Potential Impacts

Decommissioning of the Leadon infrastructure including the two sections of the pipeline bundle (PL1841 – North Bundle and PL1842 – South Bundle), the flexible flowline (PL1895), the North and South Towheads, the MLS, six gravity riser base structures clustered around the MLS, 50 spoolpieces and jumpers, 200 concrete mattresses and 2000 grout bags will require work at, or near, the seabed that may result in disturbance to the seabed sediments and water column. Structures and materials to be removed are detailed in Table 6.1.

Table 6.1: Structures to be removed and seabed impact

Structure	Dimensions	Quantity	Seabed impact (km²)
4" flexible flowline	7,315 m x 138.9 mm	1	0.001
North Towhead	29 x 6.6 x 4.6 m	1	0.00019
South Towhead	26 x 6.6 x 4.5 m	1	0.00017
MLS	41 x 6.1 x 4.5 m	1	0.00025
Riser base structures			
Rise base – 12" Aquifer	6.2 x 6.0 x 6.1 m	1	0.000037
Rise base – 12" Production	6.2 x 6.0 x 6.1 m	1	0.000037
Rise base – 6" Gas Lift	5.9 x 5.3 x 6.1 m	1	0.000031
Rise base – 6" Gas Import	5.9 x 5.3 x 6.1 m	1	0.000031
Rise base – 8" test	5.9 x 5.3 x 6.1 m	1	0.000031
Rise base – Umbilical	4.8 x 4.0 x 3.5 m	1	0.000019
Spoolpieces and jumpers			
From North Towhead to wells: P4, P3, P9, P6, P10, P5 & P8	168.3 x 14.3 mm	9	0.000000022
	60.3 x 5.5 mm	9	0.000000003
From North Towhead to well: W1	168.3 x 11 mm	2	0.000000004
	88.9 x 7.6 mm	2	0.000000001
From MLS to 6" Import Gas & Gas Lift Spool	168.3 x 11 mm	6	0.000000011
From MLS to 12" Aquifer Spool	323.9 x 21.4 mm	3	0.000000021
From MLS to 12" Prod Spool	323.9 x 21.4 mm	3	0.000000021
From MLS to 8" test Spool	219.1 x 15.9 mm	3	0.000000010
From South Towhead to wells: P1, P2, AQ2 & P7	168.3 x 14.3 mm	6	0.000000014
	60.3 x 5.5 mm	6	0.000000002
From South Towhead to well: W2	168.3 x 11 mm	1	0.000000002
Concrete Mattresses and Grout Bags			
North Towhead	6 x 2 x 0.15 m	30	0.000360
South Towhead	6 x 2 x 0.15 m	44	0.000528
MLS	6 x 2 x 0.15 m	47	0.000564
MLS	6 x 3 x 0.15 m	57	0.001026
4" flexible flowline	5 x 3 x 0.3 m	24	0.000360
Total			**0.004 km²**

6.2.1 Rock dumping of Pipeline Bundles

The recommended option for decommissioning the two sections of the pipeline bundle is complete burial by rock dump (Section 2). The North Bundle (2,117 m) and South Bundle (2,137 m) sections will be covered by rock dump (Table 6.2). The bundle sections are currently exposed on the seabed and are designed to be over-trawlable. Since their installation in 2001, a degree of backfill has occurred, although it is not completely buried at any location (Maersk, 2013).

As described within Section 2, between 69,000 and 84,000 tonnes of rock will be required to provide sufficient cover for the pipeline bundle, resulting in a footprint of approximately 0.05 km² assuming that the rock dump will be 4,254 m long, 12 m wide and cover the top of the bundle to a height of 0.6 m. The amount of rock dump was estimated following consultations with fishermen, which indicated that to limit any potential impact, a rock berm with a slope of 1 in 3 along the full length of the bundle is preferred.

The burial of the pipeline bundle will create a local, short-term impact to water quality resulting from the disturbance of the seabed and suspension of fine particulate matter from the rock during the rock dump.

The long-term consequences of the burial of the pipeline bundle with rock are expected to result from burial of benthic organisms and change in habitat type, as well as the slow corrosion of the pipeline over time leading to its eventual collapse and a depression in the middle of the rock dump profile.

Corrosion of the pipeline bundle will leave traces of corroded metal and broken concrete buried under the rock dump mass. The pipeline will have been flushed and cleaned prior to burial. However, approximately 15 kg of oil residue could be released into the sea causing a short-term impact to the water and sediment quality. Additionally, 3.7 tonnes of copper and 18.7 tonnes of aluminium-zinc-indium alloy will slowly dissipate into the sea. The slow release of these metals is expected to have a negligible impact on the local environment, as the erosion of the rock dump covered bundle is expected to be slow (55% weight loss over 145 years) and a relatively small amount of material would be redistributed over the surrounding sediment (Maersk, 2012).

The long-term consequences of the rock dump will be a change of habitat, as a result of the introduction of hard substrate into a predominantly soft substrate environment. This has been assessed during the risk assessment as having a minor local impact.

Table 6.2: Bundle details

Item	Description	Dimensions (m)	Weight in air (tonnes)
North Bundle (PL1841)	42.5” diameter bundle: • 16” production (18” sleeve) • 8” test (10” sleeve) • 10” water injection • 6” gas lift • control tubes and cables run on 200 x 100 mm cable ladder	2,117	1,934
South Bundle (PL1842)	47.5” diameter bundle: • 12” production (16” sleeve) • 8” test (10” sleeve) • 12” water injection • 16” aquifer • 4” gas lift • control tubes and cables run on 200 x 100 mm cable ladder	2,137	2,382

Source: Maersk, 2013.

6.2.2 Removal of Subsea Structures

A 7.4 km, 4” gas import flowline (PL1895) runs between a valve structure within the Beryl Alpha 500 m zone and the Leadon MLS. The flowline is laid in an open trench that has accumulated a degree of natural backfill since installation. Prior to disconnection protective mattresses will be removed and the line will be purged to remove residual hydrocarbon gas. The flexible flowline will be removed from the site to be decommissioned onshore. It is anticipated that the flowline would be largely recycled with over 95% of the multi-layer material, including metals and plastic recovered.

The 7.5 km 4" flexible flowline will be cut as close as practicable to either side of the already buried 50 m section (to ensure that minimal jetting is required). The ends of the 50 m section, which will remain in place under the Apache operated Skene North Bundle Replacement will be lowered to a depth of 0.6 m. The ownership and decommissioning liability for this 50 m section will be maintained by Maersk and will be considered as part of the on-going monitoring programmes.

At each of the drill centres, the bundle is terminated in a towhead structure that incorporates all of the connections between the flowlines and the individual wells. A similar MLS is located halfway along the bundle length and contains the connections between the bundle and the riser bases. These structures are integral to the bundle. In addition to the towheads and the MLS, six gravity riser base structures which are clustered around the MLS are to be removed. None of the structures are piled.

A total of 50 spoolpieces and jumpers that are to be removed are currently covered by protective concrete mattresses. This and other infrastructure is protected by a total of 200 concrete mattresses and 2000 grout bags. Groutbags, mattresses and spool pieces will be speed loaded into baskets. These 4 x 2 m ($8m^2$) baskets may cause additional short term localised disturbance to the seabed during operations. Impacts will be localised to positions directly adjacent to the items being lifted.

The removal of the flexible flowline, towheads, MLS, riser bases, spoolpieces, jumpers and protective structures will cause short term seabed disturbance resulting from displacement of sediment on the seabed and turbidity from re-suspended sediment in the water column. This may result in the temporary burial, displacement and potential smothering of the seabed fauna which would be readily recolonized. There may also be a transient deterioration of the water quality as a result of contamination following the removal of residual hydrocarbon gas from the flexible flowline. The seabed footprint impacted by the removal of the above structures is estimated at 0.004 km^2, and the overall impact was assessed as negligible (Maersk, 2012).

6.2.3 Disturbance of the Cuttings Pile

Drill cuttings disturbance has not been considered within this document, since wellhead decommissioning is not within the decommissioning scope of work for the current ES. It should be noted however that a technical review of Maersk's North Sea Fields, with regard to OSPAR recommendation 2006/5, concluded that no further investigation was required on the Leadon Field (ERT, 2008).

Of all the 24 wells drilled in the Leadon Field, only two (9/14a-9 and 9/14a-8) were drilled using oil based mud (OBM) which was subsequently discharged to sea (ERT, 2008; Maersk, 2014). A total of 398 and 688 tonnes of OBM, respectively, were discharged at the surface for each of the wells (ERT, 2008). These two wells were drilled at some distance from each other and are not considered to have contributed to a single cuttings pile, as defined by OSPAR Recommendation 2006/5 (ERT, 2008).

Although drilling history was unavailable for a number of wells which have been drilled, these were all either single well sites or drilled after the cessation of OBM discharge in any field operated by Maersk on 1st January 2001 (Maersk, 2014).

6.2.4 Potential for dropped objects

There is the potential for the loss of objects during the decommissioning process. Depending on size, dropped objects may present a hazard to shipping and subsea infrastructure and fishing activities such as trawling. Dropped objects may also impact on the seabed community within the drop zone. Dropped objects can vary in size from tools to large sections of topsides infrastructure or the loss of a vessel.

The worst case scenario which imposes the greatest environmental and socioeconomic impact for a dropped object would be the sinking of a vessel during operations. More likely would be the release of part of the infrastructure during cutting operations or poor placement of rock dump

This type of event may cause localised effects in the water column, on the seabed or to the benthos. The extent and severity of these effects would depend on what is lost and the conditions prevailing at the time. It is probable that any seabed contamination and benthic impact would be largely confined to areas which are already experiencing perturbation as a result of past activities at Leadon and the presence of drill cuttings.

All efforts will be made by Maersk to minimise the risk of dropped objects. A dropped objects study will be carried out prior to the project implementation, and used during the development of operational control and safety procedures. During decommissioning operations, a debris survey will be conducted prior to commencement and following completion of the work. Tools and equipment used will be accounted for before and after completion of each task. Items to be stored, lifted, moved on or between vessels, offloaded in port or transported will be placed in containers or secured by sea-fastenings which will be specifically designed for the intended cargo or otherwise secured to prevent loss wherever practicable. Items to be lifted will be identified and all cuts will be pre-planned. Lifts will also be pre-planned, carried out using cranes specifically designated for the purpose. Warps, slings and other fastenings will be certified, inspected and used according to control procedures.

Following the completion survey of the seabed around the worksite, the potential recoverability of any lost objects from the Leadon Field will be assessed, and recovery of significant debris will be undertaken to minimise the impact on the environment and risk to other users of the sea, wherever practicable.

6.3 Impacts to Sensitive Receptors

The direct effects of seabed perturbation include mortality as a result of physical disturbance, smothering by moving heavy subsea equipment such as the towheads, and in extreme cases by the displaced and re-suspended sediment and habitat modification owing to changed physio-chemical characteristics (such as sediment porosity and oxygenation). Table 6.3 summarises the potential decommissioning activities and whether they could result in a short or long term impact to the seabed.

6.3.1 Seabed Sediments and Benthic Fauna

Seabed sediments in the wider Leadon area are comprised of poorly sorted very fine sands, with hydrocarbon, heavy and trace metal concentrations within natural levels for North Sea sediments (Gardline Surveys, 2001). The macrofaunal community of the Leadon Field is typical of the wider northern North Sea area (Gardline Surveys, 2001).

Suspension of sediments as a result of rock dump, the removal of subsea structures or the dropping of objects is likely to physically disturb benthic fauna living on or in the sediment close to the centre of disturbance, smothering benthic fauna in the immediate area.

Sediments that are re-suspended during decommissioning activities will drift with seabed currents before settling out over adjacent areas of seabed. The lateral spread of re-suspended sediments is expected to be limited due to the weak subsea currents in the Leadon area and at worst case this could have a negligible impact on the local community (Maersk, 2012). In extreme cases, re-suspended sediments might smother surrounding benthic communities, but otherwise this impact area will be limited to the immediate vicinity of the disturbance. Such an impact is comparable to the natural burial of fauna from sediment movement due to subsea currents.

Following the completion of decommissioning activities, the natural physical processes of sediment transportation is expected to restore the seabed habitat to its original condition. Upon cessation of the subsea decommissioning activities, it is expected that the resettled sediment will be quickly recolonised by benthic fauna typical of the area. This will occur as a result of natural settlement by larvae and plankton and through the migration of animals from adjacent undisturbed benthic communities (Dernie *et al*., 2003).

6.3.2 Habitat Change

Placement of protective rock dump will have a minor impact on the structure of the seabed in these areas. The impact will be limited to approximately 0.05 km^2.

The proposed rock dump will result in an impact that has been assessed as minor (Maersk, 2012). As organisms associated with hard substrates may naturally be present in the area, areas of rock dump will create a relatively small additional rocky habitat along the pipeline route for epibenthic organisms. Such organisms typically include tubeworms, barnacles, hydroids, tunicates and bryozoans, which are commonly found on submerged rocky outcrops, boulders and offshore structures rather than on sediment.

The seabed feature that will result from the rock dump may provide habitats for crevice-dwelling fish (e.g. ling, conger eel and wolf fish) and crustaceans (e.g. squat lobsters and crabs) and may attract fish species to the site (Lissner *et al*., 1991).

Table 6.3: Summary of potential sources of seabed disturbance and resulting in environmental impacts from each decommissioning activity or outcome

Decommissioning activity/outcome	Environmental Impact				
	Water column		Seabed sediments		
	Release of contaminants	Suspended matter	Release of contaminants	Burial and smothering	Change in habitat
Rock dump pipeline bundle		Short-term		Long-term	Long-term
Over time corrosion and collapse of the bundle	Long-term	-	Long-term	Long-term	-
Removal of flexible flowline	Short-term	Short-term	Short-term	Short-term	-
Removal of North and South Towheads and MLS		Short-term		Short-term	
Removal of riser bases		Short-term		Short-term	
Removal of spoolpieces and jumpers		Short-term		Short-term	
Removal of concrete mattresses and grout bags		Short-term		Short-term	
Potential for dropped objects		Short-term		Short-term	

6.4 Cumulative and Transboundary Impacts

No cumulative impacts from other activities that could impact the seabed in the area are anticipated.

No transboundary impacts on the seabed are anticipated as a result of the decommissioning activities.

6.5 Proposed Mitigation Measures

The planned mitigation measures that will be undertaken to minimise the disturbance to the seabed arising from the decommissioning of the Leadon Field are given in Table 6.4.

Table 6.4: Potential sources of impact and planned mitigation measures relating to seabed disturbance during decommissioning

Potential source of impact	Planned mitigation measures
Removal of subsea infrastructure	• Minimize disturbance of seabed through planned and careful removal of structures
Rock dumping along pipeline bundles	• This impact will be minimised by controlled rock dump over a minimal footprint.
Dropped objects	• Dropped objects study will be carried out • Development of operational control and safety procedures • Pre and post-seabed surveys

6.6 Conclusions

The environmental impacts to the seabed emerging from the proposed Leadon Decommissioning activities include:

- Rock dump activities associated with the pipeline bundle burial are assessed as being of negligible to minor significance to the environment and will impact the water column and the sediment through modification of the seabed and physical disturbance causing suspension of material.
- Removal of the flexible flowline, towheads, riser bases, spoolpieces, jumpers, associated protective structures and the accidental dropping of objects are assessed as being of negligible significance to the environment and will temporarily impact water quality and cause physical disturbance causing suspension of material. These effects will be short-term and will be followed by natural recolonisation.

7.0 PHYSICAL PRESENCE

This section outlines the potential environmental and socioeconomic impacts associated with the physical presence of subsea structures in the Leadon Field and the vessels required for its removal.

For clarity, this chapter covers physical presence only. The short-term environmental impacts to the seabed caused by the removal of the subsea structures are discussed in Chapter 6. The short-term environmental impacts of the vessel presence are discussed in Chapters 8 through to 11.

7.1 Approach

The following concerns have been raised during the consultation (Chapter 4) and Risk Assessment processes (Chapter 5 and Appendix B), and include:

- Physical presence of decommissioning vessels causing potential interference to other users of the sea;
- Damage to or loss of gear as a result of subsea obstructions left in place, posing potential snagging risks; and
- Long term environmental impacts of structures left in place.

7.2 Sources of Potential Impact

For structural removal operations, it is expected that maximum of four of Diving Support Vessels (DSV), Platform Support Vessels (PSVs), Construction Support Vessels (CSVs), Remotely operated vehicle Support Vessels (RSVs), rock dump vessels and Heavy Construction Vessels (HCVs) could be present in the area at any one time. The total time that vessels are expected to be on site is 100 days.

Based on the socioeconomic description in Chapter 3, other users of the sea in the vicinity of the Leadon Field have been identified as those involved in or responsible for:

- Commercial fisheries;
- Shipping;
- Submarine cables; and
- Oil and gas activities.

Of these, the focus is placed on commercial shipping and fishing vessels, owing to their proximity to the development location. In response to the concerns raised by the SFF during the consultation process (Chapter 4), particular emphasis is placed on the potential interaction of fishing trawlers with the remaining structures.

As outlined in Chapter 2, the only structures to remain in place will be the North and South pipeline bundles. Both rock dump and mattresses will be used to protect the pipeline bundles. The quantity of mattresses to be re-used is currently unknown but it is predicted that up to 46,000 m^3 of rock will be required to sufficiently cover the entirety of the pipeline bundles, covering a seabed area of 0.05 km^2. The long-term presence of this structure could create a snagging hazard for fishing trawlers and could also lead to the long-term alteration of the current environment around the bundle.

7.3 Impact on Sensitive Receptors

The long term physical presence of the pipeline bundles and rock dump has the potential to interfere with fishing gear, leading potentially to a loss of catch/revenue for fishermen. There may also be the potential to disrupt previously established shipping operations in the area, whilst vessels carry out removal and rock dump operations.

7.3.1 Commercial Shipping

Commercial shipping traffic density in block 9/14 is very low (DECC, 2012) and on this basis the impact to shipping is considered to be negligible. Further to this, the main structures to be decommissioned are contained within three separate 500 m exclusion zones rather than one large exclusion zone minimising the impact on shipping transit.

7.3.2 Commercial Fishing

With respect to commercial fishing further potential impacts include the loss of access to fishing grounds during decommissioning activities and the impedance to fishing gears by subsea structures.

As discussed in Section 2 the rock dump will be shaped to render it over-trawlable. The rock will be placed in one of two configurations, a trapezoid or triangular design. Figure 7.1 provides a profile of the two designs. A triangular design will require 69,000 tonnes, with an estimated footprint of 0.034 km^2. A trapezoidal design will require 83,700 tonnes with an estimated footprint of 0.042 km^2.

The designs in Figure 7.1 are predicted to withstand a minimum of between four and six trawler strikes at the same location before rock dump would be compromised. Maersk would endeavour to perform remedial works on the impacted section should this ever occur. Over-trawlability trials will be undertaken at the time of decommissioning and periodically thereafter. If the trawlability trial fails, additional rock dumping will be conducted as soon as practicable.

Demersal fish are the main target species in the Leadon area (95%, 98%, 87% and 68% in 2010, 2011, 2012 and 2013 respectively). Fishing for demersal fish involves towing the nets directly over the seabed to target mainly finfish species such as haddock and cod which are found near the seabed. Pair trawling (where two boats maintain the horizontal spread of the net without the need for otter boards) and seabed focussed otter trawls (where large rectangular otter boards keep the mouth of the trawl net open) are the main methods of fishing in ICES rectangle 48F1 (Marine Scotland, 2014). Both have the potential to interact with subsea pipelines and rock dump. The weight and width of fishing gear and the nature of the benthic substrate to a large extent determines the degree of impact.

When trawling over rock dumped sections of a pipeline, graded rock could be dragged off by bottom-towed fishing gear and spread over the seabed. In addition, the rock may cause wear and tear on the net, damage fish when caught and damage or crush the fish when unloaded.

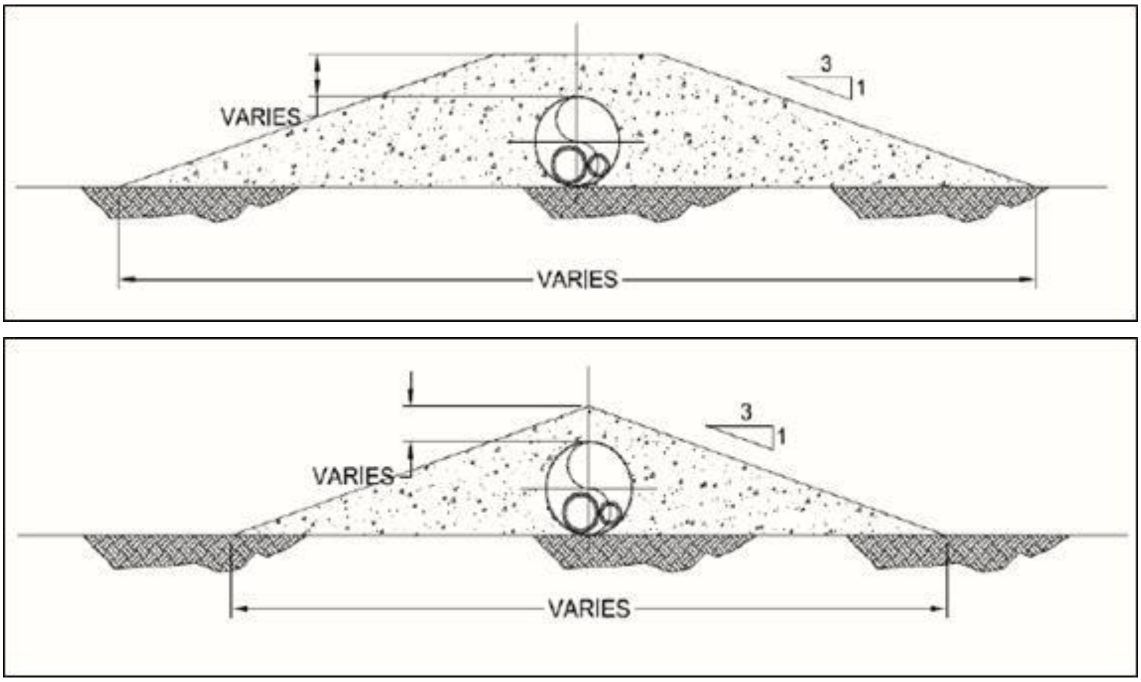


Figure 7.1: Rock dump profile options. Trapezoidal (above), Triangular (below)

During 1997, the Norwegian Institute of Marine Research conducted an over-trawling experiment to assess the risk of rock dumped pipelines to bottom trawling fishing gears (Soldal, 1997). The trial concluded that the lighter types of fishing gear with a weighted ground line were not suitable for crossing rock dumped pipelines. However, fishermen trawling this trial area for whitefish towed their gear without reported difficulty (Soldal, 1997). In addition, over-trawling tests were conducted over areas of rock dump along Statoil's 20" Sleipner condensate flowline, an area extensively fished by prawn trawlers. During 2002, meetings were held with fishermen regarding Norsk Hydro's Ormen Lange flowline in the Norwegian sector of the northern North Sea. The fishermen confirmed that they trawled over flowline rock dumps without operational problems or fishing gear damage, mainly as a consequence of using heavy net trawl gear.

7.3.3 Impacts on benthic ecology

The areas of rock dump and concrete mattresses will increase the benthic habitat for organisms that live on hard surfaces. Such organisms typically include tubeworms, barnacles, hydroids, tunicates and bryozoans, which are commonly found on submerged rocky outcrops, boulders and offshore structures. These structures could also provide habitats for crevice-dwelling fish (e.g. ling) and crustaceans (e.g. crabs); although this may introduce species not typical of the immediate area, the overall ecological change should be negligible and the impact relatively insignificant.

7.4 Cumulative and Transboundary Impacts

No cumulative impacts to other users of the sea is expected. The pipeline bundles and associated rock dump are all localised and within UK waters, so there will be no transboundary impacts.

7.5 Proposed Mitigation Measures

The planned mitigation measures that will be undertaken to minimise the impact of the long-term presence of rock dump arising from the decommissioning of the Leadon pipeline bundles are given in Table 7.1.

Table 7.1: Potential sources of impact and planned mitigation measures relating to long-term presence

Potential source of impact	Planned mitigation measures
Physical presence of decommissioning vessels causing potential interference to other users of the sea	• Prior to commencement of operations, the appropriate notifications will be made and maritime notices posted. • All vessel activities will be in accordance with national and international regulations. • Appropriate navigation aids will be used to ensure other users of the sea are made aware of the presence of vessels.
Damage to or loss of gear as a result of subsea obstructions left in place, posing potential snagging risks	• The use of a fall pipe on the rock dump vessel and the use of ROV supervision during rock dump operations would ensure that the rock dump was placed in the correct position. • On-going consultation with the SFF. • The proposed rock dump will be designed to be over-trawlable. • Subsea rock dump will be included on navigational charts. • An over-trawlability survey should be performed to ensure that the rock dump gradient is within acceptable limits. Survey will be overseen by a fisheries liaison officer.
Long term environmental impacts of the physical presence of the pipeline bundle, mattresses and rock dump on the seabed.	• On-going liability . • Post-decommissioning ROV surveys should be undertaken to ensure integrity of structure and to monitor environmental change.

7.6 Conclusions

The transient loss of access to the area during decommissioning operations is unlikely to have a significant impact on other users of the sea (i.e. commercial shipping and fishing) as traffic levels in the area of the Leadon Field are currently very low.

There is potential for loss of fishing gears, however, previous over-trawling tests indicate that the risk is minimal when using heavy net trawl gear. Damage/ loss of fishing gears will be mitigated against through a series of measures, including supervised rock dump, rock dump design, inclusion on navigational charts and a post-decommissioning over-trawlability survey. A fisheries liaison officer and the SFF will be consulted at all stages of the process. Overall, the impact for the fishing community will be minor.

Removal of the subsea structures will open new areas for fishing and provide a minor beneficial benefit.

It is highly likely that the long-term presence of the rock dump pile will encourage hard surface benthic communities to develop

8.0 DISCHARGES TO SEA

This section provides a brief summary of potential discharges to sea, the legislative framework within which such discharges are governed and a description of likely discharges resulting from the Leadon Decommissioning operations.

An accidental release of contaminated water can result in a complex and dynamic pattern of pollution distribution and impact to the marine environment. The number of factors that could influence a release, both natural and anthropogenic, renders each one unique. In many cases these impacts and receptors have been detailed in Accidental events chapter (Section 11).

8.1 Approach

As part of the decommissioning process it is important to consider the magnitude of a potential discharge of contaminated water to the marine environment and critically to assess the effects of such an unplanned event on key sensitive receptors. During Leadon Decommissioning and associated vessel operations, three discharge streams could lead to contaminated fluid entering the marine environment, namely: treated water, hydraulic fluids and residual oil. The magnitude of impacts arising from these discharge streams are described in later sections.

8.1.1 Treated water

Following cessation of production in July 2006, the Leadon subsea infrastructure was flushed then flooded with seawater dosed with 1.980 kg (1.678 mg/l) of TROS 650. A more recent study of the Leadon Decommissioning Programmes (Maersk, 2014) reveals that volumes of sea water treated with TROS 650 at 1600 ppm are as follows: 438.278 m^3 for the North Bundle and 609.00 m^3 for the South Bundle. TROS 650 is a pipeline hydrotest chemical containing an oxygen scavenger, a biocide and a corrosion inhibitor that is used to protect the subsea infrastructure against corrosion and biological growth during the suspension period.

During the decommissioning process, there is the potential for some or all of the water treated with TROS 650 to be released to the marine environment. Given that TROS 650 is currently approved for use by CEFAS, its discharge, a worst case scenario of 1 m^3 of seawater per Production, Water Injection and Aquifer riser, and 0.66 m^3 of seawater per Test riser, containing 1678.5 mg/l TROS 650 has been modelled for the PON15E. A subsea discharge from both bundles of 8.93 kg of TROS 650 has been modelled using the PEC:PNEC subsea discharge calculation which is appropriate for this type of discharge (Maersk, 2006).

The Risk Quotient (RQ) for the discharge was calculated as 0.01. This gives an $RQ < 1$ indicating that this discharge is likely to have an insignificant impact on the receiving environment (Maersk, 2006).

Additionally it should be noted that during discussions with the manufacturer of TROS 650 it was confirmed that it is reasonable to expect the efficacy of the chemicals to have decreased after the prolonged period subsea (approximately 4 years).

The treated water, potentially released during decommissioning process, will cause negligible effects on the receiving marine environment due to relatively small quantities of the fluid and quick dispersion.

8.1.2 Hydraulic fluid

The Leadon subsea control system tubing is filled with Castrol Transaqua HT2 subsea hydraulic control fluid. The total volume of hydraulic fluid contained within the bundle control tubing has been calculated at 2,054 litres. This equates to 2,054 kg of the chemical (density 1 g/cm^3). A more recent study of Leadon Decommissioning Programmes (Maersk, 2014) estimated the volumes of Transaqua chemicals used for the North and South Bundles at around 1.022 m^3 and 1.032 m^3.

The hydraulic fluid will be discharged subsea, possibly at multiple locations. However for the purpose of calculating the worst case scenario RQ it has been assumed all of the hydraulic fluid contained within the bundles will be released at one discharge point. Calculated RQ was 0.47, comfortably less than 1, indicating that this discharge is likely to have negligible impact on the marine environment.

8.1.3 Residual oil

The Leadon production pipework has been cleaned, via a series of flushes, to an oil-in-water content of <30 ppm. If the bundles are left on site, the oil residues are about 8.79 kg in the North Bundle and 6.3 kg in the South Bundle (Maersk, 2014). In total approximately 15 kg of oil may be lost.

On cutting the pipeline bundle, it is anticipated that oil may seep out slowly rather than flow positively on return to the surface, as the system is not pressurised. This will lead to smaller, slow flowing and isolated releases, rather than a larger instantaneous event. Owing to the low concentration of oil and the expected nature of release, it is expected that the oil will disperse within a short distance of the release point and that any impact will be transient and short lived. It should also be noted that these operations are currently planned during a period of relatively low seabird vulnerability.

8.1.4 Discharges from Operating Vessels

The sources of potential pollution from the operating vessels, along with proposed control and mitigation measures are summarised in Table 8.1. Overall impact of the operating vessels was assessed as low (Section 5).

Table 8.1: Sources of pollution from operating vessels with control and mitigation measures

Discharges from Operating Vessels	Environmental Risk	Control and Mitigation Measures
Overboard discharge of non-hazardous drains	• Slight deterioration in seawater quality around point of discharge. • Potential effects on marine fauna inhabiting the upper water column (plankton, fish and marine mammals).	Non-hazardous drains, by their design, discharge only non-hazardous rainwater which may be slightly contaminated with oily deposits. Access points for non-hazardous deck drains are controlled, so any spillages on deck will not enter the drainage system, but will be cleaned up. Non-hazardous drains are designed to take storm and rain water run-offs from the decks.
Discharge of treated bilge water	• Deterioration in seawater quality around the discharge point and the potential for oil slick formation. • Potential effects on marine fauna inhabiting the upper water column (plankton, fish and marine mammals).	Compliance with MARPOL which requires: • Oil-water separation and filtration equipment, monitoring and discharge to ensure oil concentration is compliant with current limits. • Retention of the bulk oil fraction after separation, for recycling or incineration onshore. UK or International Pollution Prevention Certificate for vessel drainage systems. Vessel audits to ensure compliance.
Discharge of ballast water	• Discharge of sediments and water in the ballast tanks can introduce non-native planktonic and benthic species into the water column, impacting water quality and organisms in a localised area immediately around the discharge point.	• Maersk will adhere to the International Convention for the Control and Management of Ships' Ballast Water and Sediments, adopted in 2004. • Adherence to recent ballast water guidance. Since April 2008, the Helsinki and OSPAR Commissions have issued General Guidance on the voluntary Interim application of the D1 Ballast Water Exchange Standard. The guidance requests that vessels entering NE Atlantic waters exchange all their ballast tanks at least 200 nm from the nearest land, in waters at least 200 m deep. • Maersk will ensure good practice for vessel management to minimise risk.
Overboard discharge of sewage and macerated galley waste	• Localised increase in BOD (Biological Oxygen Demand) around the point of discharge (caused by bacterial degradation of the sewage). • Input of organic nutrients results in localised increase in productivity in fish, plankton and micro-organisms. • Slight deterioration in seawater quality around point of discharge. • Potential effects on marine fauna inhabiting the upper water column (plankton and fish).	• Sewage will be treated prior to disposal at sea or contained and shipped to shore. • Vessels will be audited to ensure compliance. • Food waste will be macerated as required by MARPOL and The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008; this will aid its dispersal and decomposition in the water column.

8.2 Impacts to Sensitive Receptors

The above decommissioning discharges into the water column are potentially toxic to plankton, benthos and fish in the immediate vicinity of the discharge. Away from the discharge site, bioaccumulation in the food chain may occur (DTI, 2001). Laboratory and enclosure studies have reported that the composition and toxicity of contaminated water varies greatly, however, high dispersion rates mean that toxicity in receiving waters has rarely been demonstrated (DTI, 2001).

8.2.1 Plankton

Some toxicity to planktonic organisms may result from the release of treated water, hydraulic fluid and residual oil discharge during Leadon Decommissioning.

The localised release of contaminated water is likely to become quickly diluted within the water column to levels below those that may cause lethal or sub-lethal effects on the planktonic community (Lee and Neff, 2011; Neff, 2002). In addition, mesocosm experiments designed to simulate conditions in the North Sea found that although produced water input caused an increase in bacterial biomass, it had no discernible impact on the planktonic community (Gamble *et al*., 1987). Consequently, a short-term permitted discharge of contaminated water should not present a major risk to the viability of the plankton community.

8.2.2 Benthic Environment

Contaminated water has the potential to cause short-term toxicity or long-term impacts from harmful levels of bioaccumulation within the benthic community (DTI, 2001). The extent of these impacts depends on water column depth, produced water dispersion rates, current speed and dilution (Lee & Neff, 2011).

Water depth at Leadon range between 116 and 120 m, and it is anticipated that the contaminated water discharged during decommissioning activities will dilute to levels that are too low to cause harm to benthic organisms. Therefore, it is unlikely that benthic organisms will be impacted.

8.2.3 Fish and Shellfish

As pelagic finfish are highly mobile, it is unlikely that there will be an impact on the finfish community. In a mesocosm study on the impacts of produced water on finfish, no negative impacts were observed (Gamble *et al*., 1987). There is little likelihood of fish, shellfish or other epibenthic organisms being impacted due to the contaminated water dispersion rates.

8.2.4 Protected Habitats and Species

No Annex I habitats were identified along the Leadon field Bundle routes or in the immediate vicinity of the subsea structure to be decommissioned (Maersk, 2011; 2013). The closest Annex I habitat Braemar Pockmarks SCI is located 55 km south from the Leadon Field, therefore the release of contaminated water will have no effect on this area. The short-term release of contaminated water is unlikely to have any effect on marine mammals or Annex II species. The low number of animals in the area coupled with their high mobility suggests that no discernible impact will be observed.

8.3 Cumulative and Transboundary Impacts

The release of inhibited seawater to the marine environment during Leadon infrastructure decommissioning may result in a short-term, localised impact on marine organisms close to the discharge point. It is unlikely that there will be any cumulative impacts as a result of permitted discharge of inhibited seawater during the decommissioning activities.

The Leadon Field is located approximately 8.5 km from the UK/ Norway median line and since all identified impacts would be within UK waters, no transboundary impacts are anticipated.

8.4 Conclusions

Discharges to sea of treated water, hydraulic fluid, residual oil, as well as discharges from operating vessels during decommissioning activities will result in localised effects which will have negligible impact on the wider marine environment.

9.0 NOISE GENERATION

Sound is important for many marine organisms with marine mammals, fish and certain species of invertebrates having developed a range of complex mechanisms for both the emission and detection of sound (Richardson *et al.*, 1995). Cetaceans (whales, dolphins and porpoises) use sound for navigation, communication and prey detection. Thus anthropogenic underwater noise has the potential to impact on marine mammals (Southall *et al.,* 2007; Richardson *et al.,* 1995). Underwater noise may cause animals to become displaced from activities potentially interrupting feeding, mating, socialising, resting or migration. This may impact body condition and reproductive success of individuals or populations (Southall *et al.,* 2007; Richardson *et al.,* 1995). Feeding may also be affected indirectly if noise disturbs prey species (Southall *et al.,* 2007; Richardson *et al.,* 1995).

Human activities at sea such as shipping, geophysical surveys, blasting and drilling generate underwater noise. The characteristics of noise produced vary with the type of activity. In general, sound can be characterised with reference to two features, the frequency at which it is emitted (measured in hertz; Hz) and the strength or intensity of the sound (measured in decibels; dB). Sound levels in the marine environment diminish with distance from a source by dispersion in three dimensions and absorption by the water (Richardson *et al.*, 1995). Sound can be categorised as continuous noise where there are no sudden rises or falls in pressure or impulsive noise.

9.1 Approach

The underwater noise likely to be generated during the proposed Leadon Field decommissioning operations has been assessed. The predominant sources of sound include various types of vessels, including DSVs, rock dump and underwater tools (e.g. cutting tools).

9.1.1 Rock Dump

Rock dump will be carried out by a fall pipe vessel or a side dumping vessel. Nedwell and Edwards (2004) measured the sound from a fall pipe vessel (Rollingstone) which has a specialised underwater chute that can accurately position rock on the seabed. This vessel used Dynamic Positioning (DP) and was powered by two main pitch propellers, two bow thrusters and two azimuth thrusters. The noise associated with navigation and transit has been compared, however, the noise associated with the rock-placement has not been compared; this is not thought to give a noticeable rise in noise over background levels. This is indicative of the fact that the sound levels were dominated by vessel noise and not the rock-placement activities (Nedwell and Edwards, 2004).

As such, and as concluded in Nedwell and Edwards (2004), it is assumed that any rock-placement activities that will occur during Leadon decommissioning will be dominated by vessel noise.

9.1.2 Vessels

It is likely that most forms of oil and gas decommissioning activities are typically dominated by vessel noise which is continuous. Broadband source levels for these activities rarely exceed about 190 dB re 1 μPa m, even for a vessel using dynamic positioning (DP) and are typically much lower (Hannay & MacGillivray, 2005; Genesis, 2011). Whilst continuous noise can mask biologically relevant signals such as echolocation clicks, the sound levels are below the threshold levels for Temporary Threshold Shift (TTS) in cetaceans according to the Southall *et al.* (2007) criteria (Genesis, 2011).

The level and frequency of sound produced by vessels is related to vessel size and speed, with larger vessels typically producing lower frequency sounds (Richardson *et al.*, 1995). Noise levels depend on the operating status of the vessel and the number of vessels present on site and can therefore vary considerably with time. In general, vessels produce noise over the range 100 Hz to 10 kHz, with strongest energy over the range 200 Hz to 2 kHz.

The subsea noise levels generated by surface vessels used during the decommissioning phase are unlikely to result in physiological damage to marine mammals. Depending on ambient noise levels, sensitive marine mammals may be locally disturbed by noise from a vessel in its immediate vicinity; however, the impact is not expected to be significant.

9.1.3 Underwater Tool Use Including Cutting and Drilling

The main underwater tool use during the Leadon Field decommissioning will be for cutting using diamond wire cutting equipment. There is currently little published data on the sound generated by underwater cutting or other tools. Peak source levels of 148 to 180 dB re 1 µPa are reported for a range of diver operated tools including cutters with most energy in the frequency range 200 to 1,000 Hz (Anthony *et al*., 2009). Tool use episodes tend to be intermittent and of short duration it will not be considered further.

9.1.4 Ambient Noise

Ambient or background noise in the ocean results from sounds generated by physical factors such as wind and waves; by marine mammal vocalisations; and by other shipping.

9.2 Impacts to Sensitive Receptors

Underwater noise can affect the behaviour of or may cause injury to several different marine taxa, in particular fish and marine mammals such as pinnipeds and cetaceans.

9.2.1 Pinnipeds

Pinnipeds (seals, sea lions, and walruses) also produce a diversity of sounds, although generally over a lower and more restricted bandwidth (generally from 100 Hz to several tens of kHz). Their sounds are used primarily in critical social and reproductive interactions (Southall *et al*., 2007). Available data suggest that most pinniped species have peak sensitivities between 1 and 20 kHz (NRC, 2003). However the data available on the effects of anthropogenic noise on pinniped behaviour are limited.

The Leadon Field is over 166 km from the nearest UK coastline (Shetland) so it is unlikely that grey and common seals would be found regularly in the vicinity of the proposed development.

9.2.2 Fish

Many species of fish use sound for location of prey, avoidance of predators and for social interactions. The inner ear of fish including elasmobranchs (sharks, skates and rays) is very similar to that of terrestrial vertebrates, and hearing is understood to be present among virtually all fish (NRC, 2003). The sensory systems used by fish to detect sounds are very similar to those of marine (and terrestrial) mammals and hence sounds that damage or in other ways affect marine mammals could have similar consequences for fish (Popper, 2003).

A comprehensive review by Popper & Hastings (2009) on the effects of anthropogenic sound on fishes concluded that there are substantial gaps in the knowledge that need to be filled before meaningful noise exposure criteria can be developed. It is likely that vessel noise will result in no more than short-term local disturbance to fish species.

9.2.3 Cetaceans

Harbour porpoise (*Phocoena phocoena*), white-beaked dolphin (*Lagenorhynchus albirostris*), white-sided dolphin (*Lagenorhynchus acutus*), killer whale (*Orcinus orca*) and minke whale (*Balaenoptera physalus*) have been recorded as present in the area.

Characterisation of Hearing Sensitivities

There are major differences in the hearing capabilities of different marine mammal species and, consequently, vulnerability to impact from underwater noise differs between species. Southall *et al.* (2007) classified the “hearing types” of different marine mammal species (Table 9.1).

Table 9.1: Functional cetacean hearing groups

Cetacean functional hearing group	Estimated auditory bandwidth	Species sighted in the Leadon Field area
Low-frequency	7 Hz – 22 kHz	Minke whale
Mid-frequency	150 Hz – 160 kHz	White-beaked dolphin White-sided dolphin Killer whale
High-frequency	200 Hz – 180 kHz	Harbour porpoise

Sources: Southall et al., 2007; UKDMAP, 1988.

Thresholds for Injury and Disturbance to Marine Mammals

The noise level perceived by an animal (the “received noise level”) depends on the level and frequency of the sound when it reaches the animal and the hearing sensitivity of the animal. In the immediate vicinity of a high sound level source, noise can have a severe effect causing a Permanent Threshold Shift (PTS) in hearing; leading to hearing loss and ultimately, with increasing exposure, to physical injuries which are occasionally fatal. However, at greater distance from a source the noise decreases and the potential effects are diminished (Nedwell & Edwards, 2004); possibly causing the onset of only a temporary shift in hearing thresholds (TTS-onset). Hearing sensitivity, in terms of the range of frequencies and sound levels that can be perceived, varies with species and the minimum level of sound that a species is able to detect (the “hearing threshold”) varies with frequency (Nedwell *et al*., 2007; Southall *et al*., 2007).

Zones of Injury or Disturbance

The proposed precautionary threshold for zero-to-peak Sound Pressure Levels (SPL) that are likely to lead to injury (PTS) in each of the three functional hearing groups of cetaceans is 230 dB re 1 µPa (Southall *et al*., 2007). However; there is no consensus about the threshold for disturbance to marine mammals for different noise types in the literature.

Comparison of these sound thresholds with the potential sound levels expected to be generated by the decommissioning operations suggests that no cetaceans will be injured. It is likely that marine mammals will exhibit some avoidance behaviour up to approximately 100 m from the centre of operations (BMT Cordah, 2013).

9.3 Cumulative and Transboundary Impacts

No cumulative noise impacts are expected during the Leadon Decommissioning. The Leadon Field is located approximately 12 km from the UK/ Norwegian median line. At this distance, noise levels associated with the decommissioning activities would attenuate to a level lower than that likely to cause injury or disturbance to any cetacean species and hence there are unlikely to be any transboundary impacts.

9.4 Mitigation

It is worth noting that JNCC (2010b) do not consider noise from vessel activity to pose a risk of injury to marine mammals (JNCC, 2010b). The noise impact assessment undertaken supports this view, showing that there is unlikely to be any significant impact. It is therefore considered unlikely that further mitigation measures will be required outside of those identified below:

- Machinery and equipment will be in good working order and well-maintained.
- The number of vessels utilising Dynamic Positioning at any one time will be minimised and restricted as is practicable.

9.5 Conclusions

Records indicate previous sightings of five cetacean species within the study area over the period when decommissioning activities are scheduled to take place. These species are all subject to regulatory protection from injury and disturbance.

Broadband source levels for vessels associated with decommissioning activities rarely exceed about 190 dB re 1 µPa m and are typically much lower This does not exceed the thresholds for injury to cetaceans (Southall *et al.*, 2007).

Depending on ambient noise levels, sensitive marine mammals may be locally disturbed by noise from a vessel in its immediate vicinity. Although there is a degree of uncertainty associated with the noise levels generated by each vessel and activity, it follows that the sound levels for each decommissioning method are proportional to the number of vessels on site at any one time. Overall, the potential impacts to marine mammals are not significant for any of the decommissioning methods and will only result in minimal disturbance.

10.0 ATMOSPHERIC EMISSIONS AND ENERGY USE

This section quantifies and assesses the environmental significance of the energy usage and atmospheric emissions likely to arise from decommissioning the two sections of the Leadon pipeline bundle in place (completely covered with rock dump) and the complete removal of all other subsea pipelines and infrastructure. Mitigation measures to minimise emissions and optimise energy use are also included.

To facilitate the interpretation of the energy and emissions results, the calculations have been separated by component, i.e. North Bundle, South Bundle, mattresses, flowlines, spoolpieces and other structures.

10.1 Approach

The Institute of Petroleum (IoP, 2000) guidelines outline a standardised method to allow oil and gas operators to estimate the energy use and gaseous emissions from decommissioning different components and to compare between decommissioning options for each component. The main steps of this method are as follows:

- Establish a materials inventory for each component;
- Identify all operations associated with decommissioning each component;
- Identify all end points associated with decommissioning each structure, where end-points are defined as the final states of the materials at the cessation of the decommissioning operations, including the presence of material in landfill sites or on the seabed. If the end-point results in an otherwise-recyclable material being removed from the chain of utility, e.g. steel left in place on the seabed or disposed of in landfill, this is accounted for by a theoretical cost for re-manufacture of the material, with consequent energy use and emissions attributed to the decommissioning process;
- Select factors relating activity to energy use and gaseous emissions. The IoP (2000) guidelines include a database of standard conversion factors based on a wide variety of sources for current industry practice and these or site-specific values may be used, as appropriate, for the particular components being decommissioned. The factors used throughout this report (IoP or otherwise) are summarised in Appendix C; and
- Calculate the energy use and gaseous emissions based on these factors.

10.2 Potential Sources and Magnitude of Impact

The following section reports the findings of the energy and emissions assessment which considered, where appropriate, the following sources for each stage of the decommissioning of the Leadon facilities:

- Vessels for transportation and offshore operations;
- Helicopters for transportation of personnel;
- Onshore dismantling and/ or processing of materials;
- Onshore transportation to processing, recycling and landfill sites;
- Manufacture of new items (i.e. Rock dump and temporary steelwork) required for decommissioning operations;
- Recycling; and

- New manufacture to replace recyclable materials left at sea or disposed in landfill.

10.3 Vessel Use

Table 10.1 summarises the vessels expected to be associated with the decommissioning of the Leadon facilities. Days in field calculations include Wait on Weather (WOW) days.

Table 10.1: Summary of vessel use during decommissioning

Description	Vessel(s) used*	Days in field	Total fuel used (tonnes)
Recover mattresses and grout bags	DSV	10	192.2
	PSV	10	30
Recover flexible flowline by reel	CSV	9.6	187.3
Cut and recover spools	DSV	16.6	286.5
	PSV	25.5	35.1
Cut and recover structures	DSV	12.7	218.5
	HCV	8.4	151.4
	PSV (x 2)	20.4	38.8
Relocate mattresses to protect bundle ends and remove appurtenances	DSV	6.6	120.5
Rock dump length of bundle	Rock dump vessel	45.3	625
Debris clearance and as left survey	RSV	10.2	184.8
	Total:	**175**	**2,419**

** DSV - Diving Support Vessel; PSV - Platform Support Vessel; CSV - Construction Support Vessel; HCV - Heavy Construction Vessel; RSV - ROV Support Vessel*

10.4 Materials and Operations Inventories

Table 10.2 provides the values for energy usage and emissions for recycling and manufacture of new replacement materials for the materials inventory.

Table 10.2: Summary of materials and operations

Component	Steel (tonnes)	Copper (tonnes)	Concrete (tonnes)	Energy to recycle (GJ)	Energy to manufacture new (GJ)
North Bundle	1,923	1.86	-	17,358	48,273
South Bundle	2,368	1.88	-	21,356	59,381
Mattresses	-	-	1,018	N/A	1,018
Flowline	122	-	-	1,101	N/A
Spools	91	-	-	823	N/A
Structures	1,348	-	-	12,131	N/A

A summary of the anticipated emissions and energy use associated with the decommissioning components (Table 10.2) is provided in Table 10.3. Energy use (Table 10.3) has been broken-down into that associated with vessels, which relates directly to the fuel consumption of the vessels employed in the decommissioning operations, and the energy use associated with the materials to be either recovered or left in place. Energy use (materials) results account for the recycling of material returned to shore and the energy use required to re-manufacture materials left in place from raw materials (i.e the pipeline bundles).

The energy required by the offshore cutting equipment has not been included in the calculations as it was felt that this would be adequately covered by the vessel calculations (including both the additional time required for cutting and the vessel operational power requirements). Onshore cutting of infrastructure has also not been considered as it is anticipated that the majority of the cutting will take place offshore.

Table 10.3: Summary of energy use and emissions

Vessel days	175
Total fuel consumption (tonnes)	2,419
Atmospheric emissions (tonnes CO_2)	7,740
Energy use (vessels (GJ))	89,224
Energy use (materials (GJ))	122,727
Total energy (GJ)	211,951

The main source of atmospheric emissions during decommissioning will result from diesel burnt for power generation for the vessels in the field. Atmospheric emissions are broken down into CO_2, carbon monoxide (CO), NO_X, nitrous oxide (N_2O), sulphur dioxide (SO_2), methane (CH_4) and other VOCs (Table 10.4).

Table 10.4 Predicted atmospheric emissions from vessel power generation

Gas[1]	Tonnes released (worst-case scenario)
CO_2	7,740
CO	19.35
NO_X	142.70
N_20	0.53
SO_2	9.67
CH_4	0.65
VOC	5.80

1 Emission factors used from Oil and Gas UK (2014) EEMS Annual Report 2013

The emissions from the proposed decommissioning operations (7,740 tonnes CO_2; Table 10.4) represent 0.054% of the total annual CO_2 offshore emissions from the UKCS (14,312,280 tonnes CO_2; OGUK (2014)).

In preparation for the removal of the flexible flowline, the line will need to be purged of 0.6 tonnes of natural gas and flooded with seawater. The line will be flushed with seawater from a subsea valve structure at Beryl Alpha, with gas being vented at the Leadon MLS. The line will be flushed at a minimum speed of one metre per second, resulting in a maximum venting period of just over two hours. In terms of the global warming potential, this quantity of methane is equivalent to a release of 7.2 tonnes of CO_2, representing 0.00005% of the total annual CO_2 offshore emissions from the UKCS (14,312,280 tonnes CO_2; OGUK (2014). A venting consent will be obtained for this operation.

10.5 Impacts on Sensitive Receptors

The atmospheric emissions listed in Table 10.4 have the potential to impact sensitive receptors in the area. The direct effect of the emission of CO_2, CH_4 and VOCs is the implication for climate change (CH_4 has 21 times the global climate change potential of the main greenhouse gas CO_2 (IPPC, 2007)) and contribution to regional level air quality deterioration through low-level ozone production. The indirect effects of low level ozone include deleterious health effects, as well as damage to vegetation, crops and ecosystems (Sitch *et al*., 2007). However for offshore activities the indirect effects are not an issue.

The direct effect of NO_x, SO_x and VOC emissions is the formation of photochemical pollution in the presence of sunlight. Low level ozone is the main chemical pollutant formed, with by-products that include nitric and sulphuric acid and nitrate particulates. The effects of acid formation include contribution to acid rain formation and dry deposition of particulates. The main environmental effect resulting from the emission of SO_2 is the potential to contribute to the occurrence of acid rain; however the fate of SO_2 is difficult to predict due to its dependence on weather (Seinfeld and Pandis, 1998).

The exposed offshore conditions will promote the rapid dispersion and dilution of these emissions. Outside the immediate vicinity of the Leadon decommissioning activities, all released gases would only be present in low concentrations. The Leadon facilities are located approximately 170 km east of the Shetland coastline. There are no proposed or designated conservation sites located in close proximity that would be impacted by these atmospheric emissions.

Harbour porpoise are the only Annex II species recorded with frequent sightings in the vicinity of the Leadon facilities. In the open conditions that prevail offshore, the atmospheric emissions generated during the decommissioning activities would be readily dispersed. The atmospheric emissions from the proposed activities are therefore considered unlikely to have any effect on marine mammals or any other sensitive receptors.

10.6 Cumulative and Transboundary Impacts

The potential cumulative effects associated with atmospheric emissions produced by the decommissioning activities include a contribution to climate change by emission of greenhouse gases, acidification (acid rain) and local air pollution.

The local CO_2 emissions from the proposed decommissioning operations for Leadon (7,740 tonnes CO_2) represent 0.05% of the total annual CO_2 offshore emissions from the UKCS in 2013 (14,310,000 tonnes CO_2) (OGUK, 2014).

Given the proximity of the UK/ Norwegian median line, a simple dispersion model has been used (Davis & Cornwell, 1991; Appendix D) to predict the concentration of some of the key atmospheric gases at various distances from the Leadon area. This model is based on the concurrent use of an HCV, a DSV and two PSVs (representing the maximum daily consumption). Table 10.5 demonstrates that emissions disperse rapidly over a short distance indicating that transboundary effects will be negligible even with a downwind scenario. Maersk will adhere to the protocol listed in Table 10.6 to ensure that local environmental impacts are minimised.

The Leadon Field is located approximately 12 km from the UK/ Norwegian median line. Released gases may be present in very low concentrations across this boundary. However, under the exposed offshore conditions, the quantity of additional air emissions produced is unlikely to create any measurable transboundary impacts.

Table 10.5: Predicted combustion gases contributions to atmospheric concentrations downwind during multiple vessel operations

Gas	Concentration (µg/m^3)									
	0.5 km	1 km	2 km	3 km	4 km	5 km	10 km	20 km	30 km	50 km
CO_2	43.80	17.73	6.64	3.53	2.32	1.62	0.57	0.19	0.11	0.06
CO	0.215	0.087	0.033	0.017	0.011	0.008	0.003	0.001	0.001	0.00
NO_X	0.8131	0.3291	0.1233	0.0656	0.0431	0.0301	0.0106	0.0035	0.0020	0.0011
SO_2	0.0548	0.0222	0.0083	0.0044	0.0029	0.0020	0.0007	0.00023	0.00014	0.00008
CH_4	0.00246	0.00100	0.00037	0.00020	0.00013	0.00009	0.00003	0.000010	0.000006	0.000003
VOC	0.0274	0.011	0.004	0.002	0.0015	0.0010	0.0004	0.00012	0.00007	0.00004

10.7 Mitigation

Mitigation measures to minimise atmospheric emissions and energy consumption are detailed within Table 10.6.

Table 10.6: Mitigation Measures

Planned mitigation measures
Vessels will be audited as part of selection and pre-mobilisation.
All generators and engines will be maintained and operated to the manufacturers' standards to ensure maximum efficiency.
Vessels will use ultra-low sulphur fuel in line with MARPOL requirements.
Work programmes will be planned to optimise vessel time in the field.
Fuel consumption will be minimised by operational practices and power management systems for engines, generators and other combustion plant and maintenance systems.
All mitigation measures will be incorporated into contractual documents of subcontractors.

10.8 Conclusions

The following conclusions can be derived:

- Energy use and consequent emissions from the decommissioning activities will have a localised effect on air quality. The impact on air quality is unlikely to affect any receptors in the Leadon area as the impact is expected to be limited to the immediate vicinity of the operations. For this reason, there is unlikely to be a significant transboundary or cumulative impact on air quality.
- Total CO_2 emissions generated from the proposed decommissioning operations (including gas flowline venting) will represent a very small proportion (0.05%) of the of the total annual CO_2 offshore emissions from the UKCS.
- Power generation emissions during decommissioning activities will be minimised by advanced planning to ensure efficient operations through well maintained equipment and generators and regular monitoring of fuel consumption.

Intentionally blank page

11.0 ACCIDENTAL EVENTS

This section evaluates the impact of accidental spills and describes planned prevention measures to reduce their probability. It also discusses proposed contingency measures and mitigation strategies in the event of a significant hydrocarbon release.

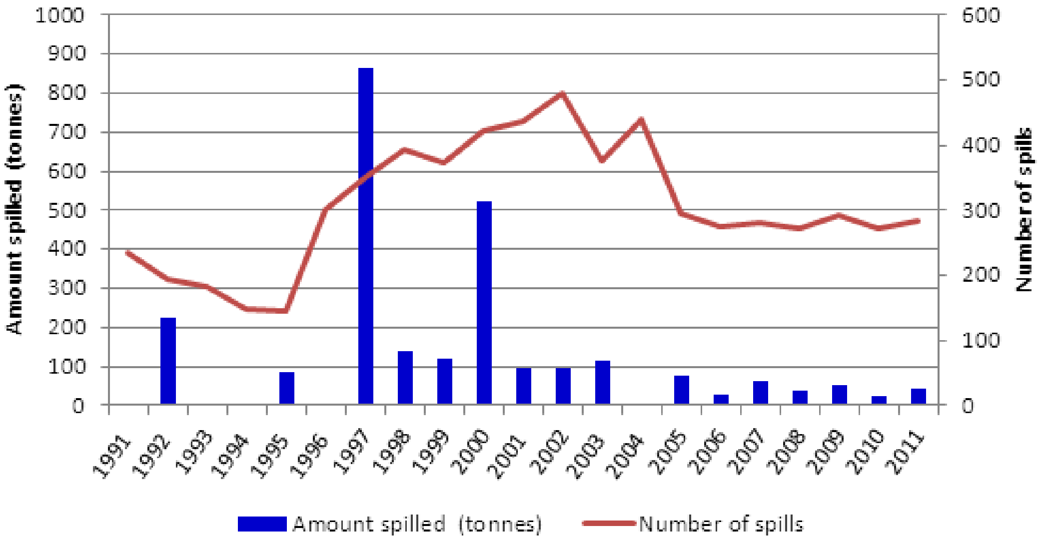
Owing to the dynamic physical conditions of the marine environment, an accidental release of hydrocarbons or other chemicals can result in a complex pattern of pollution distribution and impact to the marine environment. As part of the ES process it is necessary to estimate the extent and impact of an unplanned release of hydrocarbons, critically assess the effects of such an event on key receptors, and identify suitable prevention strategies and effective response measures.

11.1 Approach

All offshore activities carry a potential risk of a hydrocarbon or chemical spillage to sea. During the period 1975 to 2007, a total of 17,012 tonnes of oil was discharged from 5,826 individual spill events on the UKCS (UKOOA, 2006). Analysis of spill data between 1975 and 2005 shows that 46% of spill records related to crude oil, 18% to diesel and the other 36% to condensates, hydraulic oils, oily waters and other materials (UKOOA, 2006).

In 2013, 280 accidental oil releases were reported totalling 70 t of oil. That year 38.46 million metric tonnes of oil were produced, meaning that the total volume of hydrocarbons lost equated to 0.0002 % of total oil produced (OGUK, 2014). From 2011 to 2013 197 t of oil were released from 733 accidental incidents. Of these, 719 incidents were small volume releases with 302 releases totalling less than 0.001 t (1 kg).

Historically, the likelihood of an oil spill occurring in the UKCS rose from 1975 to 2011 with increased oil and gas activity. Figure 13.1 shows both the amount of oil spilled and the total number of spills recorded annually (spills < 1 tonne) on the UKCS between 1991 and 2011 (DECC, 2013b).



Source: DECC, 2012.

Figure 11.1: Number of spills and spill amounts from 1991 to 2011

11.2 Assessment of Impact

The environmental impact of a spill depends on numerous factors including:

- Location and time of the spill;
- Spill volume;
- Hydrocarbon or chemical properties;
- Prevailing weather/ metocean conditions;
- Environmental sensitivities; and
- Efficacy of the contingency plans.

The Leadon Field is located in the UKCS Northern North Sea approximately 4.3 miles to the East of the Beryl Field, 190 miles NNE of Aberdeen and 5.1 miles from the UK/ Norwegian transboundary line in a water depth of approximately 120 m.

Operations at the Leadon Field have been suspended following the departure of the FPSO, leaving the remaining sub-sea facilities in-place to wait decommissioning of the field.

A hazard identification and spill probability assessment focusing on the remaining subsea infrastructure of the suspended Maersk Leadon Field has been undertaken. Potential hazards under previous production operations are no longer considered a risk because previously detailed sources are now virtually hydrocarbon free or are no longer in place, as the Leadon Field is now suspended. A total of 8.79 kg and 6.3 kg of oil residue are estimated to remain in the North and South Bundles, respectively, with a further 0.49 kg remaining in the spool pieces and jumpers. Furthermore, no gas lift exists to enable the wells to flow, the subsea infrastructure is fluid filled with inhibited water and the tree valves isolations have been proven.

A Guard Vessel has been contracted to remain infield at all times to monitor the remaining infrastructure and guard from any approaching vessels. There will be up to four vessels on site at any one time during the decommissioning operations. It is a collision between two of these vessels which poses a risk of an oil spill.

11.2.1 Hydrocarbon properties

The fate and effect of a spill is dependent on the chemical and physical properties of the hydrocarbon. Diesel has very high levels of volatile components, evaporating quickly on release. The low asphaltene content in the diesel prevents emulsification, reducing persistence of these fuels in the marine environment. Owing to its characteristics and subsequent behaviour when released, diesel oil is not considered to offer a significant threat to the environment.

11.2.2 Overview of modelling undertaken

Spill modelling was undertaken for two potential spill scenarios to identify a worst-case release, its fate and behaviour, area of impact (including potential beaching locations) and likelihood of crossing transboundary lines.

The assessment was conducted using BMT's Oil Spill Information System (OSIS) model which can simulate the fate and dispersion of surface oil slicks. OSIS has been jointly developed by BMT and AEA Technology plc. (Walker, 1995). The resulting surface slick is modelled for an instantaneous release of diesel, until the slick has been dispersed by evaporation.

The worst-case scenarios were originally modelled for the purpose of the Leadon Field Oil Pollution Emergency Plan (OPEP). The results of the OPEP modelling are representative of the impact of a potential accidental discharge of hydrocarbons from a vessel collision. Trajectory models are available: these simulate a point source spill scenario under a single set of metocean conditions; a continuous 30 knot wind speed towards the UK coastline and a continuous 30 knot wind speed towards the nearest Median line, in this case using bearings of 103° and 271° from the release site, respectively.

The current scenarios were based on the potential loss of inventory from two 200 m^3 tanks of marine diesel: a 400 m^3 (141 tonnes) instantaneous release until surface oil is insignificant.

11.2.3 Modelling results

For both scenarios, the trajectory models predict that the diesel will persist on the surface for 8 hours and that there will be no beaching. It is likely that the spill will cross the UK/ Norwegian median line before the oil disperses. The properties and path of the surface oil slick are presented in Table 11.1 and Figures 11.2 and 11.3.

Table 11.1: Trajectory Scenarios for Vessel Collision at the Leadon Field

	Length of slick (km)	Evaporated Volume (m^3)	Dispersed Volume (m^3)
Shetland			
Vessel collision scenario (400 m^3)	17.9	163.75	236.25
Norway			
Vessel collision scenario (400 m^3)	18.5	163.47	236.53

Figure 11.2: Instantaneous diesel spill resulting from a vessel collision towards the UK coastline. Track (in red) and final particle positions (black)

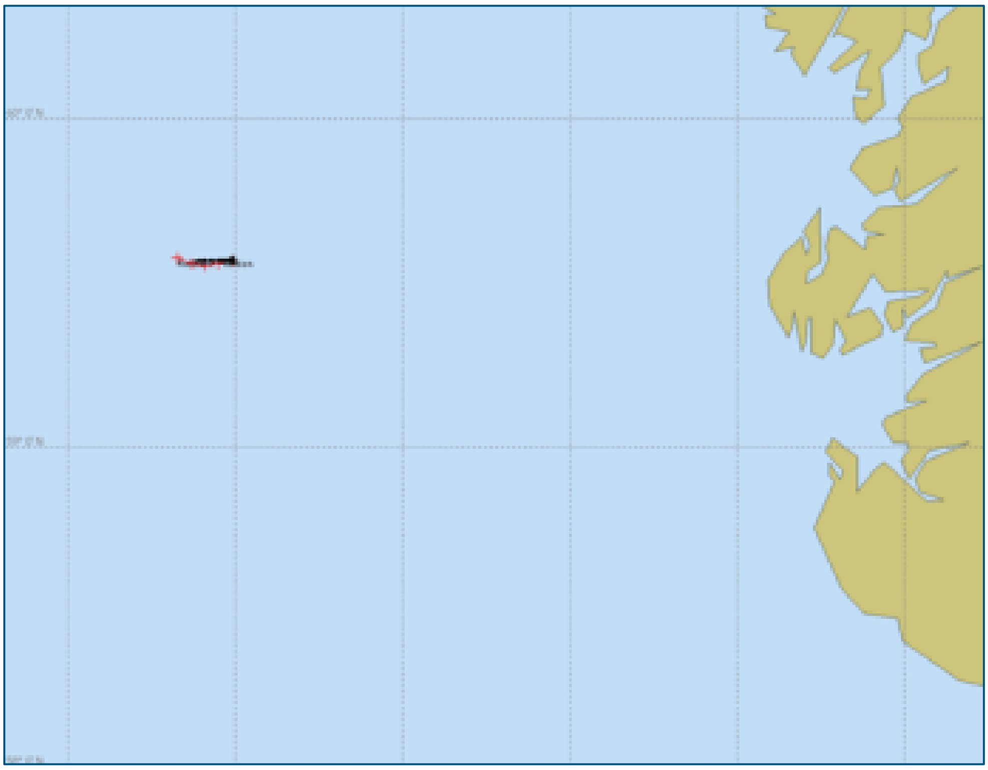


Figure 11.2: Instantaneous diesel spill resulting from a vessel collision towards the UK/ Norway median line. Track (in red) and final particle positions (black)

11.3 Impacts to Sensitive Receptors

Although the likelihood of a hydrocarbon spill at the Leadon Field is remote, there is a potential risk to organisms in the immediate marine environment if a spill were to occur. As the potential spill is likely to be on the surface planktonic and benthic communities are unlikely to be influenced by an accidental spill from the Leadon Field. Other communities, including fish, birds and marine mammals may be impacted. However, the impact is likely to be negligible as the high proportion of light ends in the diesel mean that the oil will evaporate and disperse within approximately 8 hours.

11.4 Cumulative and Transboundary Impacts

Maersk will liaise with operators of nearby fields to limit activities occurring at the same time as much as reasonably possible. The closest operation is Beryl Apache, operated by Apache, approximately 7km away (Figure i). Coordinating will reduce the risk of collision and reduce the potential for cumulative impacts on the environment.

No cumulative impacts are expected from a release of diesel fuel unless similar spills were to occur in the immediate vicinity.

There is a potential for transboundary transport of contaminants. Modelling predicts that the most likely trajectory for an accidental spill will cross the median line. Depending on the size of the spill, in the event of an oil spill entering Norwegian waters it may be necessary to implement the NORBRIT Agreement (the Norway-UK Joint Contingency Plan). The NORBRIT Agreement sets out command and control procedures for pollution incidents likely to affect both parties, as well as channels of communication and available resources. The MCA Counter Pollution and Response Branch also has agreements with equivalent organisations in other North Sea coastal states, under the Bonn Agreement 1983. Applicable international arrangements are further described in Appendix A.

11.5 Conclusions

The worst case single trajectory modelling suggests oil will travel a distance of approximately 18 to 19 km either towards the UK coastline or towards the UK/ Norwegian median line. It is likely that the spill will reach and potentially cross the UK/ Norwegian median line before the oil disperses, however, it will not beach. Any impact to sensitive receptors is likely to be negligible as the high proportion of light ends in the diesel mean that the oil will evaporate and disperse within approximately 8 hours.

Intentionally blank page

12.0 ENVIRONMENTAL AND WASTE MANAGEMENT

Maersk is committed to conducting activities in compliance with all legislation and operates an ISO14001 certified Environmental Management System (EMS) as part of the wider Business Management System (BMS). In addition the management of waste materials will pose several challenges to the EMS.

12.1 Environmental Management

Maersk's EMS was independently certified to ISO14001 in 2011. Their commitments to ensuring protection of the environment are set out in their Health, Safety & Environment (HSE) Policy (Figure 12.1). The EMS covers all aspects of Maersk's activities including exploration, drilling and production activities. All activities associated with the decommissioning of the Leadon infrastructure will be covered by the EMS.

The EMS is comprised of five key elements:

1. Policy.
2. Organisation.
3. Planning and Implementation.
4. Performance Management.
5. Audit and Management Review.

Together these five elements form Maersk's "Plan-Do-Check-Act" approach to HSE management which actively promotes continual improvement in all aspects of the organisation's activities.

The management system is subject to internal reviews and audits. Audits are planned and progress is reported monthly to senior management. In addition, Maersk periodically evaluates compliance with environmental legislation, including applicable permits, licences and other requirements. All non-conformances with legislative requirements are reported and investigated.

Maersk's contractor management processes require that all contractors conform to either Maersk's EMS or the contractor's own management system. As part of the selection process, the contractor's capabilities with respect to environmental management are evaluated with audits being performed to verify environmental capability. The contractor's capabilities are assessed to varying levels dependent on the environmental, health or safety criticality of the service in question.

Maersk Oil North Sea UK Limited

Health, Safety & Environment (HSE) Policy

Maersk Oil UK will always as a minimum comply with all applicable national and European Legislation, and with industry good practice in the areas of health, safety and environment. Maersk Oil UK fully embraces the Maersk Oil HSE Policy and requirements of the Maersk Oil Corporate Management System.

The key objective of our policy is to continually strive for improvement in HSE performance, through appropriate organisation and effective management systems.

At Maersk Oil UK we promote a culture that recognises incident-free operations as an achievable goal, that delivers not only excellent HSE performance, but additional benefits to individuals and society. At Maersk Oil UK it is the responsibility of everyone to work towards incident-free operations.

Implementation of our policy

In order to meet our policy objectives Maersk Oil UK shall provide the necessary organisation to continually carry out the following critical activities:

- Provide a Business Management System which reflects the requirements of health, safety, security and environmental legislation and policy, and provides adequate instruction and guidance to meet organisational objectives.
- Always provide constant care and attention to all our activities in order to avoid error and maximise our ability to excel in providing a safe workplace.
- Act responsibly and ethically to ensure that our activities do not cause harm of any kind.
- Provide systematic risk identification and control.
- Ensure people are competent to conduct our business safely, securely and responsibly with minimum impact on the environment.
- Train and coach our personnel to maintain and develop their competence to be able to keep up to date with technology and techniques in order that lower risk options are identified as they become available.
- Identify and use good practice wherever possible and share our practices with others and learn from them.
- Carry out our business in an environmentally responsible manner that minimises the use of resources, maximises recycling, and minimises the release of potentially polluting materials.

Maersk Oil, Maersk House, Crawpeel Road, Altens, Aberdeen AB12 3LG
T: +44 (0) 1224 242000 F: +44 (0) 1224 242595 www.maerskoil.com

MAERSK OIL

Figure 12.1: Maersk's Health, Safety & Environment (HSE) Policy

12.2 Waste Management

Decommissioning activities will generate quantities of controlled waste, defined in Section 75(4) of the Environmental Protection Act 1990 as ‘household, industrial and commercial waste or any such waste’. For example, the individual lift of major components onto a barge for subsequent dismantling within controlled conditions onshore at dedicated facilities. The sequence and quantities of controlled waste generated at any one time will depend on the processes used for dismantling, such as offshore deconstruction, reverse installation or heavy lift and single lift, and the subsequent treatment and disposal methods.

Three key challenges associated with waste management for the Leadon facilities are:

- The generation of large quantities of controlled waste which require detailed planning to manage the logistics of transport to shore, temporary storage and onward treatment/ disposal of materials.
- The potential for large quantities of “problematic” materials to be generated due to the cross–contamination of non-hazardous waste with substances that have hazardous properties, resulting in the material being classified as special waste. Special waste is defined as material that has one, or more, properties that are described in the Hazardous Waste Directive (91/689/EEC) as amended by Council Directive 94/31/EC. Outside of Scotland such material is referred to as hazardous waste.
- The problem associated with materials with unknown properties at the point of generation. These quantities of “unidentified waste” require careful storage and laboratory analysis to determine whether they are special waste or non-hazardous waste. In accordance with the DECC Guidance Notes (under the Petroleum Act 1998 (DECC, 2011)), which affirm that the disposal of such installations should be governed by the precautionary principle, Maersk will assume the worst case, particularly when dealing with hazardous and unidentified wastes. Waste treatment options will be chosen in accordance with the Waste Management Strategy (Section 12.3.2).

12.2.1 Waste Generation

Typical non-hazardous waste will include scrap metals, concrete and plastics that are not cross-contaminated with special waste and can therefore be removed and recovered for reuse or recycling. Special waste will include Waste Electrical and Electronic Equipment (WEEE), oil contaminated materials, asbestos, batteries and chemicals. Many types of special waste generated during decommissioning are routinely generated during production and maintenance of offshore installations. However, the decommissioning process may generate significantly greater quantities of both non-hazardous waste and special waste when compared to routine operations and as such requires careful management.

The likely types and quantities of materials associated for the following facilities are provided within Section 2 (Table 2.2):

- materials associated with structures including towheads, the MLS and riser bases
- materials associated with surface laid pipelines, flowlines and connectors
- ancillary materials i.e. concrete mattresses and grout bags

Radioactive Waste

No NORM wastes are known to be present in the Leadon Field. In the unlikely event that such wastes are detected, NORM will be managed in line with legislative requirements (Appendix A). The Radioactive Substances Act 1993 Amendment (Scotland) Regulations 2011 regulates the handling, storage, transfer and disposal of such waste.

Draining, Flushing Purging and Venting

Following cessation of production in 2006, the in-field pipework were drained, flushed, purged and vented. These initial cleaning activities removed gross hydrocarbon fluids, chemicals, gases and other hazardous inventories from the system.

12.3 Legislation and Corporate Standards

There is no waste-related legislation that specifically covers decommissioning activities, but some aspects of general waste legislation are relevant (Appendix A).

Whether a material or substance is 'waste' is determined by EU law. The EU Waste Framework Directive (WFD) (2006/12/EC) defines 'directive waste' as "any substance or object in the categories set out in Annex 1 of the Directive which the holder discards or intends or is required to discard". Annex 1 provides a list of definitions and includes a general category – "Any materials, substances or products which are not contained in the above categories."

The action of removal and transfer of redundant installations and infrastructures during decommissioning to shore falls within the legal definition of waste; and the responsibility for determining whether a substance or object is waste lies with the operator. Having determined the substance or object is waste, subsequent storage, handling, transfer and treatment of the waste is then governed by a number of regulations (Appendix A).

12.3.1 Waste Management Hierarchy

The DECC Guidance Notes (2011) require that the decommissioning decisions are consistent with the waste hierarchy and the decision recognises that, in line with the waste hierarchy, the reuse of an installation is first in the order of preferred decommissioning options. Demonstration of how Maersk intends to implement the waste hierarchy is included in the Decommissioning Programme for the Leadon facilities.

Non-hazardous materials, such as scrap metal, concrete and plastics not contaminated with hazardous (special) waste, shall be removed and recovered for reuse or recycling. Steel and other scrap metal are estimated to account for the greatest proportion of materials inventory from the Leadon towheads, riser bases, MLS, flexible flowline, and bundle sections. Recycling is expected to be the most significant end point for materials recovered from the Leadon facilities. Non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site.

In summary:

Recover & recycle	Towheads, riser bases, MLS, flexible flowline, North and South Bundle sections
Landfill	Non-recyclable mattresses and grout bags
Left in place	Bundle sections

12.3.2 Waste Management Strategy

Maersk will prepare a Waste Management Strategy (WMS) outlining aims and objectives with respect to the management of waste generated from decommissioning the Leadon facilities. The WMS also outlines the international and national regulatory framework and explains how Maersk's future decomissioning activities will comply with these legal requirements and meet other company policy obligations.

12.3.3 Leadon Facilities Waste Management Plan

A Leadon Decommissioning Waste Management Plan (WMP) will be developed to translate the WMS into individual project plans with defined actions, roles and responsibilities. The onshore location for dismantling and disposal of wastes from the Leadon facilities has not yet been decided.

12.3.4 Contractor Management

Waste management activities include the handling, storage and treatment of waste offshore, the transfer of waste to a waste treatment or dismantling yard for further storage, handling and treatment as appropriate, and then further transfer to the final disposal or treatment point. Many of these activities will be conducted by contractors and sub-contractors on behalf of Maersk.

Although Maersk will commission contractors to undertake the work, the legal liability, i.e. Duty of Care, for all waste generated from decommissioning remains with Maersk throughout all these activities. Maersk's liability includes the decommissioned bundle that will remain in place on the seabed and periodically be monitored (Section 2.7.4).

12.3.5 Measuring and Monitoring Performance

Measuring and monitoring performance is an important element of an EMS and Maersk already has a number of mechanisms in place to do this. Regarding the management and minimisation of waste during decommissioning, the key areas for action are:

- Monitoring legislative compliance.
- Measuring performance in achieving waste minimisation.

A number of methods will be used to ensure effective monitoring of waste management activities including, for example, auditing of contractors and disposal sites.

Intentionally blank page

13.0 CONCLUSIONS

An EIA is an important management tool used to ensure that environmental considerations are incorporated into Maersk decommissioning planning and decision making. This ES presents the findings of an EIA which compared and assessed potential options for decommissioning of the Leadon infrastructure. It provides information for the evaluation of environmental consequences from the proposed activities.

13.1 Key concerns

Following identification of interactions between the proposed decommissioning activities and the local environment, an assessment of potentially significant environmental impacts, and the stakeholder consultation, the key environmental concerns identified for impact assessment were as follows:

• Habitat change as a result of pipeline rock dump	(Section 6)
• Seabed disturbance during decommissioning – i.e. removal of infrastructure, rock dump	(Section 7)
• Physical presence of vessels causing potential interference with other users of the sea	(Section 7)
• Discharges to sea	(Section 8)
• Disturbance from underwater noise generated during decommissioning activities	(Section 9)
• Effects of energy use and atmospheric emissions	(Section 10)
• Non-routine events – spillage of hydrocarbons and other fluids	(Section 11)

13.2 Key sensitivities

The marine environment where the Leadon facilities are located is typical of the northern North Sea. While recognising that there are certain times of the year when populations of seabirds, fish spawning and commercial fisheries are vulnerable to oil pollution, the conclusion is that the area is not particularly sensitive to the proposed activities.

There are no known Annex I habitats in the area of the Leadon facilities. Harbour porpoise were the only Annex II species of the Habitats Directive recorded within and around the Leadon facilities. They exhibit very high abundance in February, high abundance in July and September, mid abundance levels in August and low numbers in December, January and April to June (UKDMAP, 1998).

13.3 Maersk commitments

Maersk's mitigation strategies to minimise the impact on the above environmental concerns is in line with current industry best practice. Maersk have an established EMS which will be used to ensure that the proposed mitigation measures are implemented (Section 12).

The preventative measures proposed should be sufficient to reduce the risk of these unplanned events to a level that is as low as reasonably practicable, or to control and mitigate the effects in the event of their occurrence. Maersk's commitments for the Leadon decommissioning project are summarised below (Table 13.1).

13.1 Maersk commitments table for the Leadon Decommissioning Programme

Impact to	Maersk Commitment
Seabed Disturbance	• Where rock dump is required, a fall pipe (or similar) will be used to ensure accurate placement and limited disturbance. • Maersk will ensure that retrieval operations minimize unnecessary seabed disturbance. • Maersk have committed to undertake pre- and post- decommissioning ROV surveys and will undertake real-time monitoring of rock dump operations. • Maersk will endeavour to undertake operations outside the main period of fish spawning to limit the impact on fish stocks.
Physical Presence	• Maersk will mitigate against risk to the commercial fishing fleet by using established (trawler-friendly) rock dump techniques. Over-trawlability tests of the rock dump will be carried out to ensure that the rock dump profile will allow fishing nets to trawl over the rock unobstructed. • Maersk have committed to undertake pre- and post- decommissioning ROV surveys. • Maersk will endeavour to undertake operations outside the main period of seabird vulnerability to limit the impact on seabirds.
Discharges to Sea	• Vessels will be audited as part of the selection process to ensure that machinery, equipment, drainage systems, oil/water separators, bunding, cranes, fuel and lubricant storage tanks, fuel transfer equipment and hoses will be in good working order and well-maintained.
Noise Generation	Maersk are committed to the following mitigation measures: • Machinery and equipment will be in good working order and well-maintained. • The number of vessels utilizing DP at any one time will be minimised and restricted to DSVs, supply and anchor handling vessels. • Work programmes will be planned to optimise vessel time in the field. • Diamond wire cutting equipment will be used to make the subsea cuts rather than explosives.
Atmospheric Emissions	Maersk are committed to ensuring that the following mitigation is in place: • Vessels will be audited as part of selection and pre-mobilisation. • All generators and engines will be maintained and operated to the manufacturers' standards to ensure maximum efficiency and use ultra-low sulphur fuel. • Work programmes will be planned to optimise vessel time in the field. • Fuel consumption will be minimised by operational practices and power management systems for engines, generators and other combustion plant and maintenance systems. • All mitigation measures will be incorporated into contractual documents of subcontractors.
Accidental Events	Maersk will ensure that all vessels present in the area during decommissioning activities are familiar with the approved OPEP in place for the Leadon Decommissioning Programme, and that all personnel with responsibility for the oil pollution incident response must be competent, both in oil pollution incident response and in the use of their OPEP. Maersk will endeavor to undertake operations outside key periods of seabird sensitivity.
Waste	Maersk will minimize the uptake of resources and the amount of recovered material sent for recycling will be maximized as much as is technically and financially viable.
Lessons Learned	Maersk will carry out a post-project review to ensure all lessons learned during decommissioning will be recorded and communicated within the organization, to their key contractors, and to the industry (if applicable).

The overall risk to the environment from both routine and accidental events is therefore considered to be negligible or minor. In addition, incremental cumulative impacts of the activities will be minimal and there will be no transboundary effects. The integrity of statutory conservation sites designated or likely to be designated under the Habitats Directive is not considered to be at risk.

13.4 In summary

This ES concludes that the environmental risk reduction measures to be taken by Maersk should provide sufficient safeguards to minimise impact to the local environment. Monitoring during the implementation of these safeguards, including the provision of both pre- and post- decommissioning surveys and long-term monitoring of the pipeline bundles will ensure that the commitments made and strategies employed represent best environmental practice.

Intentionally blank page

14.0 REFERENCES

Adams, J.A. (1987). The primary ecological sub-divisions of the North Sea: some aspects of their plankton communities. In: Baily, R.S., Parrish, B.B. (Eds.), Developments in Fisheries Research in Scotland. Fishing New Books, Surrey, UK, pp. 165–181

Anthony, T. G., Wright, N. A., & Evans, M. A. (2009). Review of diver noise exposure. Report by QinetiQ for the Health and Safety Executive. Research Report No. RR735. (No. RR735).

Basford, D. J., Eleftheriou, A., & Raffaelli, D. (1989). The epifauna of the northern North Sea (56°– 61°N). *Journal of the Marine Biological Association of the United Kingdom, 69*(02), 387-407.

Basford, D. J., Eleftheriou, A., & Raffaelli, D. (1990). The infauna and epifauna of the northern North Sea. *Netherlands Journal of Sea Research, 25*(1–2), 165-173.

Bjørge, A., & Tolley, K. A. (2002). *Encyclopedia of marine mammals* (2 ed.): San Diego, Academic Press.

BMT Cordah (2013). Bressay Development Environmental Statement. DECC reference: D/4157/2013.

Breuer, E., Stevenson, A. G., Howe, J. A., Carroll, J., & Shimmield, G. B. (2004). Drill cutting accumulations in the northern and central North Sea: a review of environmental interactions and chemical fate. Marine Pollution Bulletin 48, 12-25.

BSI (1996). BS EN ISO14001:1996 Environmental management systems - specification with guidance for use. London, British Standards Institute.

BSI (2004). BS EN ISO14001: Environmental management systems - specification with guidance for use. London, British Standards Institute.

CEFAS (2001a). North Sea fish and fisheries. Technical report TR_003 produced for Strategic Environmental Assessment - SEA2.

CEFAS (2001b). Contaminant status of the North Sea: SEA2.

Connor, D. W., Allen, J. H., Golding, N., Howell, K. L., Lieberknecht, L. M., Northen, K. O., & Reker, J. B. (2004). The marine habitat classification for Britain and Ireland Version 04.05. JNCC, Peterborough, ISBN 1 861 07561 8 (internet version).

Coull, K. A., Johnstone, R., & Rogers, S. I. (1998). *Fisheries sensitivity maps in British Waters.* (Vol. 1): UKOOA Ltd. Available online: http://www.cefas.co.uk/media/29947/sensi_maps.pdf [Last Accessed March 2015]

Davis M.L. and Cornwell D.A. (1991). Introduction to Environmental Engineering. McGraw-Hill International. p 459.

DECC [Department of Energy & Climate Change] (2009). UK Offshore Energy - Strategic environmental assessment future leasing for offshore wind farms and licensing for offshore oil and gas and gas storage. from www.offshore-sea.org.uk/consultations/Offshore_Energy_SEA/

DECC (2011). Guidance notes for decommissioning of offshore oil and gas installations and pipelines under the Petroleum Act 1998 (as amended). Version 6. March 2011. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69754/Guidance_Notes_v6_07.01.2013.pdf [Last Accessed March 2015]

DECC (2012). Guidance Notes to Operators of UK Offshore Oil and Gas Installations (including pipelines) on Oil Pollution Emergency Plan Requirements (as amended July, 2012). *UKOOA*.

DECC (2013a). 27th Seaward Licensing Round https://www.gov.uk/government/consultations/27th-seaward-licensing-round [Last Accessed 2015]

DECC (2013b). (2013). http://og.decc.gov.uk/en/olgs/cms/ data_maps/field_data/oil_spills/oil_spills.aspx. [website accessed: July, 2013]

DECC (2014). Oil and Gas: Offshore Maps and GIS shapefiles. Online: https://www.gov.uk/oil-and-gas-offshore-maps-and-gis-shapefiles [Last accessed March 2015]

DTI (2001). Report to the Department of Trade and Industry. Strategic Environmental Assessment of the Mature Areas of the Offshore North Sea SEA2. Consultation Document, September 2001, British Geological Survey. Available Online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197798/SEA2_Assessment_Document.pdf [Last Accessed: March 2015]

Douglas, G., Hall, P. B., Bowler, B., & Williams, P. F. V. (1981). Analysis of hydrocarbons in sediments as indicators of pollution. Proceedings of the Royal Society of Edinburgh Section B (Biology), 80B, 113-134.

Ellis, J. R., Cruz-Martínez, A., Rackham, B. D., & Rogers, S. I. (2004). The distribution of Chondrichthyan fishes around the British Isles and implications for conservation. J. Northw. Atl. Fish. Sci., Vol. 35: 195-213. Available online: http://journal.nafo.int/35/ellis/5-ellis.pdf [Last Accessed: March 2015]

Ellis, J. R., Milligan, S. P., Readdy, L., Taylor, N., & Brown, M. J. (2010). Spawning and nursery grounds of selected fish species in UK waters. *Report to the Department of Environment, Food, and Rural Affairs from CEFAS. Science Series Technical Report no. 147.* Available online: http://www.cefas.defra.gov.uk/publications/techrep/TechRep147.pdf [Last Accessed: March 2015]

European Commission (2007). Interpretation manual of European Union habitats EUR27. Available online: http://ec.europa.eu/environment/nature/legislation/habitatsdirective/docs/2007_07_im.pdf [Last Accessed March 2015]

European Environmental Agency (2011). Status of marine fish stocks (CSI 032). Available online: http://www.eea.europa.eu/data-and-maps/indicators/status-of-marine-fish-stocks/status-of-marine-fish-stocks-8 [Last Accessed March 2015]

Evans, P. G. H. (2008). Selection criteria for marine protected areas for cetaceans (Sea Watch Foundation). Held at the European Cetacean Society's 21st Annual Conference, The Aquarium, San Sebastian, Spain, 22nd April 2007

Fowler, S., Mogensen, C., & Blasdale, T. (2004). Plan of action for the conservation and management of sharks in UK Waters. *JNCC report no.360*. Available online: http://jncc.defra.gov.uk/pdf/jncc360.pdf [Last Accessed March 2015]

Gamble, J. C., Davies, J. M., Hay, S. J., & Dow, F. K. (1987). Mesocosm experiments on the effects of produced water discharges from offshore oil platforms in the northern North sea. Sarsia, 72(3-4), 383-386.

Gardline Surveys (2001). Baseline Environmental Survey around the Leadon Development at UKCS 9/14a – Leadon and Glassel Sites. Report N° 5520. A report produced for Kerr-McGee Oil (UK) plc.

Genesis (2011). Review and Assessment of Underwater Sound Produced from Oil and Gas Sound Activities and Potential Reporting Requirements under the Marine Strategy Framework Directive. Genesis Report for DECC, J71656.

Hammond, P. S., Berggren, P., Benke, H., Borchers, D. L., Collet, A., Heide-Jørgensen, M. P., et al. (2002). Abundance of harbour porpoise and other cetaceans in the North Sea and adjacent waters. Journal of Applied Ecology, 39.

Hannay, D. E., & MacGillivray, A. (2005). Comparative environmental analysis of the Piltun-Astokh field pipeline route options: Sakhalin Energy Investment Co.Ltd.

Harwood, J., & Wilson, B. (2001). The implications of developments on the Atlantic Frontier for marine mammals. Continental Shelf Research, 21(8–10), 1073-1093.

Hydrographer of the Navy (2000). North Coast of Scotland Pilot: north and north-east coasts of Scotland from Cape Wrath to Rattray Head including Caledonian Canal, Orkney Islands, Shetland Islands and Føroyar (Faeroe Islands). ed. J.E.J. Marshall, Great Britain, Hydrographic Office. 304pp.

IoP (2000). The Institute of Petroleum. Guidelines for the Calculation of Estimates of Energy Use & Gaseous Emissions in the Decommissioning of Offshore Structures. Available online: http://www.energypublishing.org/__data/assets/file/0005/6278/Pages-from-GUIDELINES-FOR-THE-CALCULATION-OF-ESTIMATES-OF-ENERGY-USE-DECOMMISSIONING-OFFSHORE-STRUCTURES.pdf [Last Accessed: March 2015]

IPPC. (2007). Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, 2007. Cambridge University Press, Cambridge, U.K. and New York, NY, USA.

ISS (2009). ROV Inspection / Survey of Maersk Field Assets 2009. Integrated Subsea Services 2009.

JNCC [Joint Nature Conservation Committee]. (2007). UK BAP priority marine species. Report on the Species and Habitat Review. Available online:

http://jncc.defra.gov.uk/PDF/UKBAP_Species-HabitatsReview-2007.pdf [Last Accessed March 2015]

JNCC (1999). Seabird Vulnerability in UK Waters: Block Specific Vulnerability, 1999. Joint nature Conservation Committee, Aberdeen.

JNCC (2010a). EUSeaMap. *Modelled Seabed Habitats for Celtic and North Lea Layer*, Available online: http://www.emodnet-seabedhabitats.eu/webgis [Last accessed: March 2015]

JNCC (2010b). *The Protection of marine European Protected Species from Injury and Disturbance. Guidance for the Marine area in England and Wales and the UK Offshore Marine area.*

JNCC (2010c). SAC selection: 1351 Harbour porpoise (*Phocoena phocoena*) Available online: http://jncc.defra.gov.uk/protectedsites/sacselection/species.asp?FeatureIntCode=S1351 [Last Accessed March 2015].

JNCC (2013). Bioscribe: A Biotope Decision Support Tool Redefining Biotopes at a Regional Scale. Available online: http://jncc.defra.gov.uk/page-5776 . [Last Accessed: March 2015]

JNCC (2014a). Offshore SACs http://jncc.defra.gov.uk/page-1455 [Last Accessed: March 2015]

JNCC (2014b). The Habitats Directive: selection of Special Areas of Conservation in the UK. Available online: http://jncc.defra.gov.uk/sacselection [Last Accessed March 2015]

Johns, D. G., & Reid, P. C. (2001). An overview of plankton ecology in the North Sea. Technical report produced for Strategic Environmental Assessment – SEA2. Sir Alister Hardy Foundation for Ocean Science. Technical Report 5. Available online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197335/TR_SEA2_Plankton.pdf [Last Accessed March 2015]

Johnston, C. M., Turnbull, C. G., & Tasker, M. L. (2002). Natura 2000 in UK Offshore Waters. *JNCC Report 325*

Judd, A. G. (2001). Pockmarks in the UK Sector of the North Sea. *Technical report (SEA 2) to the DTI*.

Kerr McGee (2000). Leadon Field Development Environmental Statement. September 2000.

Korevaar, C.G. (1990). North Sea Climate based on observations from ships and lightvessels. Kluwer Academic Publishers.

Künitzer, A., Basford, D., Craevmeersch, J. A., Dewarumez, J. M., Dorjes, J., Duineveld, G. C. A., *et al.* (1992). The benthic infauna of the North Sea: species and assemblages. *ICES Journal of Marine Science, 49*.

Lee, K., & Neff, J. (2011). Produced Water: Environmental Risks and Advances in Mitigation Technologies Springer.

McDougall, J. (2000). Section 5.1. The significance of hydrocarbons in sacrificial sediments from the Atlantic Margin regions. In: Hydrocarbons in environmental surveys of the seafloor of the UK Atlantic margin. Atlantic Frontier Environmental Network [CD-Rom]. Available from Geotek Ltd, Daventry, Northants, NN11 5EA.

Maersk (2006). Maersk Oil North Sea Ltd – PON15E Leadon Field 9/14a and 9/14b.

Maersk (2009). Bundle Survey Comparison. Report No: LEA-LEA108-SU-RE-0011

Maersk (2011). Maersk UK 2011 ROV Inspection Campaign.

Maersk (2013). Maersk UK 2013 Subsea Inspection Programme.

Maersk (2014). Maersk Oil North Sea Ltd – Leadon Decommissioning Programmes. May 2013. LEA-LEA108_SU-RE-0019

Marine Scotland (2014). Fishing Effort and Quantity and Value of Landings in ICES Rectangles. Available online: http://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData [Last Accessed: March 2015]

Nedwell, J. R., & Edwards, B. (2004). A Review of Measurements of Underwater Man-Made Noise Carried out by Subacoustech Ltd , 1993 – 2003. Subacoustech Ltd Report Ref 534R0109.

Nedwell, J. R., Turnpenny, A. W. H., Lovell, J., Parvin, S. J., Workman, R., Spinks, J. A. L., & Howell, D. (2007). A validation of the dBht as a measure of the behavioural and auditory effects of underwater noise. Subacoustech Report No. 534R1231 To: ChevronTexaco Ltd, TotalFinaElf Exploration UK PLC, DSTL, DTI, Shell UK Ltd

Neff, J. M. (2002). Chapter 11 - Radium Isotopes in the Ocean. In Bioaccumulation in Marine Organisms (pp. 191-201). Oxford: Elsevier.

Neff, J. M. (2005). Composition, environmental fates, and biological effects of water based drilling muds and cuttings discharged to the marine environment. *Petroleum Environmental Research Forum (PERF) and American Petroleum Institute*.

NRC (2003). Ocean noise and marine mammals. National Reasearch Council of the National Academies, Washington DC.

NTSF [North Sea Task Force] (1993). North Sea quality status report. Oslo and Paris Commission, London.

OGUK [Oil & Gas UK]. (2012): Oil & Gas UK EEMS Annual Report 2010. Key UK Oil and Gas Industry Environmental Data (April 2012).

OGUK (2014). Oil & Gas UK Environment Report 2014. Oil & Gas UK (November 2014).

OSPAR [Oslo Paris Convention] (1998). OSPAR decision 98/3 on the Disposal of Disused Offshore Installations. OSPAR Commission, Paris.

OSPAR (2000). Quality status report 2000 Region II Greater North Sea. OSPAR Commission 2000.

OSPAR (2005). Agreement on background concentrations for contaminants in seawater, biota and sediment. OSPAR Agreement 2005-6.

Patin, S. (1999). Environmental impact of the offshore oil and gas industry. Eco-Monitoring Publishing.

PDI (2009a). Leadon Decommissioning Study Decommissioning Inventory. Project Development International (PDI). Report no.LEA-LEA108-SU-IR-0002

PDI (2009b). Comparative Assessment Report. Project Development International (PDI). Report no: LEA-LEA108-SU-RE-0004

PDI (2012). Leadon Decommissioning Study. Comparative Assessment II. Prepared for Project Development International (PDI). Report no: C122-GN-0021

Popper, A. N. (2003). Effects of Anthropogenic Sounds on Fishes. Fisheries, 28, 24-31.

Popper, A. N., & Hastings, M. C. (2009). The effects of anthropogenic sources of sound on fishes. Journal of Fish Biology, 75(3):455-489.

Rees, H. L., Eggleton, J. D., Rachor, E., & Vanden Berghe, E. (2007). *Structure and dynamics of the North Sea benthos.* ICES Cooperative Research Report No. 288

Reid, J. B., Evans, P. G. H., & Northridge, S. P. (2003). Atlas of Cetacean Distribution in Northwest European Waters. *JNCC*, Peterborough. Available online: http://jncc.defra.gov.uk/pdf/cetaceansatlas_web.pdf [Last Accessed March 2015]

Richardson, W. J., Greene Jr., C. R., Malme, C. I., & Thomson, D. H. (1995). Marine mammals and noise. Academic Press, San Diego.

SCANS II (2006). Small Cetaceans in the European Atlantic and North Sea. *Final Report to the European Commission*. Available Online: http://biology.st-andrews.ac.uk/scans2/documents/final/SCANS-II_final_report.pdf. [Last Accessed: March 2015]

Scottish Government (2015). Marine Protected Area Network. Online: http://www.gov.scot/Topics/marine/marine-environment/mpanetwork/developing/designationOrders [Accessed March 2015]

Seazone Group (2014). Hydrospatial wrecks and obtrusions database. http://www.seazone.com/marine-maps/product/hydrospatial-wrecks

Seinfeld, J H.; Pandis, S. N., (1998). Atmospheric Chemistry and Physics — From Air Pollution to Climate Change. John Wiley and Sons, Inc

Sitch, S., Cox, P. M., Collins, W. J., Huntingford, C. (2007). Indirect radiative forcing of climate change through ozone effects on the land-carbon sink, Nature 448, pp 791

SMRU (2001). Background information on marine mammals relevant to SEA2. Strategic Environmental Assessment - SEA2 Technical Report 006 - Marine Mammals. Available Online: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/197334/TR_SEA2_Mammals.pdf [Last Accessed March 2015]

Soldal, A.V (1997). Trawling across rock covered pipelines in the North Sea (in Norwegian, English summary). Fisken og Havet 10, Institute of Marine Research, Bergen, Norway.

Southall, B. L., Bowles, A. E., Ellison, W. T., Finneran, J. J., Gentry, R. L., Greene, C. R., et al. (2007). Marine Mammal Noise Exposure Criteria: Initial Scientific Recommendations Aquatic Mammals, 33(4):411-509.

Stone, C.J.(1997). Cetacean Observations during Seismic Surveys in 1996. JNCC Report No. 228. Available Online: http://jncc.defra.gov.uk/pdf/cetaceous%20observations%201996.pdf [Last Accessed: March 2015]

Svitzer. (2001). UKCS 9/14, Leadon Bundle Installation & Off Bottom Tow Area Pipe route Survey. Report 29/12/00-10/01/01. Document Number ER9714-33-RP-002B

Tran, K., Yu, C., and Zeng, E. (1995). Petrogenic and Biogenic Sources of N-alkanes off San Diego, California. ftp://ftp.sccwrp.org/pub/download/DOCUMENTS /AnnualReports/1994_95AnnualReport/ar05.pdf [Last Accessed March 2015]

UKBenthos (2009). Version 2, December 2009. Database of offshore benthic environmental surveys in the UK sector of the North Sea. UKOOA.

UK Oil and Gas Data (2014). Oil and Gas GIS Data.

UKDMAP (1998). United Kingdom Digital Marine Atlas – An atlas of the Seas around the British Isles: Software 3rd edition. British Oceanographic Data Centre, Birkenhead.

UKOOA (2002). United Kingdom Offshore Operators Association. Guidelines on Atmospheric Emissions Inventory 2002.

UKOOA (2006). Report on the Analysis of DTI UKCS Oil Spill Data from the Period 1975-2005. A Report Prepared by TINA Consultants.

Walker, M. (1995). The Oil Spill Information System (OSIS) and Eurospill Models: Background Documentation. ASMO International Workshop, The Hague, 15-17 November 1995. Modelling of Accidental Spills and Other Calamities At Sea. 13pp.

Williams, J. M., Tasker, M. L., Carter, I. C., & Webb, A. (1995). A method of assessing seabird vulnerability to surface pollutants. *Ibis, 137*, S147-S152.

Wilson, B., Thompson, P.M., Hammond, P.S. (1997) Habitat use by bottlenose dolphins: seasonal distribution and stratified movement patterns in the Moray Firth, Scotland. J Appl Ecol 34:1365–1374

APPENDICES

Intentionally blank page

APPENDIX A: LEGISLATION

This appendix presents a summary of the key regulatory drivers applicable to the Leadon Facilities Decommissioning project as well as the policy, legal, and administrative framework within which this EIA was carried out.

Table A.1: Decommissioning

Regulatory Body	Legislation	Summary of Requirements
DECC, MMO, Marine Scotland	Petroleum Act 1998	The Petroleum Act 1998 sets out requirements for undertaking decommissioning of offshore installations and pipelines including preparation and submission of a Decommissioning Programme.
	Energy Act 2008	Part III of the Energy Act 2008 amends Part 4 of the Petroleum Act 1998 and contains provisions to enable the Secretary of State to make all relevant parties liable for the decommissioning of an installation or pipeline; provide powers to require decommissioning security at any time during the life of the installation and powers to protect the funds put aside for decommissioning in case of insolvency of the relevant party.
	Food and Environment Protection Act 1985 Marine (Scotland) Act 2010 Marine and Coastal Access Act 2009	The Marine and Coastal Access Act (MCAA) and Marine (Scotland) Act will replace and merge the requirements of FEPA Part II (deposits to the sea) and the Coast Protection Act (navigation). FEPA Part II remains in force in Scottish territorial waters to cover reserved activities (within 3 nautical miles). Many offshore sector activities are exempt from the acts; however certain activities including deposits of substances or articles in the seabed during abandonment and decommissioning operations are covered.
	OSPAR Decision 98/3 on the Disposal of Disused Offshore Installations	Lays down the general principle of forbidding the dumping and the leaving wholly or partly in place of disused offshore installations in the maritime area covered by the OSPAR Convention. The Decision recognises potential difficulties in removing large steel jackets weighing more than 10,000 tonnes and concrete gravity base structures and provides a facility for derogation from the main rule of complete removal such that the option of leaving the jacket footings or concrete structure in place may be considered.
	International Maritime Organisation (IMO) Guidelines and Standards for the Removal of Offshore Installations and Structures on the Continental Shelf and in the Exclusive Economic Zone 1989	These Guidelines and Standards represent the "generally accepted international standards" as mentioned in UNCLOS, Article 60, which prescribes that any installations or structures which are abandoned or disused shall be removed to ensure safety of navigation and to prevent any potential effect on the marine environment.
	OSPAR Recommendation 2006/5 on a management scheme for offshore cuttings piles	This recommendation outlines the approach for the management of cuttings piles offshore. The first stage of the Recommendation is to be carried out within two years of the Recommendation coming into effect with the second stage completed in a predetermined timeframe laid out in stage 1. This Recommendation entered into force from 30 June 2006.

Table A.2: General

Regulatory Body	Legislation	Summary of Requirements
Maritime and Coastguard Agency (MCA)	MARPOL 73/78	The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes and covers pollution by oil, chemicals, harmful substances in packaged form, sewage and garbage. The MCA has regulatory authority over those aspects of the offshore oil and gas industry that fall under the MARPOL Convention 73/78, including machinery space discharge, sewage discharges and garbage at sea. The Convention currently includes six technical Annexes: • Annex I Regulations for the Prevention of Pollution by Oil (entered into force 2 October 1983). • Annex II Regulations for the Control of Pollution by Noxious Liquid Substances in Bulk (entered into force 2 October 1983). • Annex III Prevention of Pollution by Harmful Substances Carried by Sea in Packaged Form (entered into force 1 July 1992). • Annex IV Prevention of Pollution by Sewage from Ships (entered into force 27 September 2003). • Annex V Prevention of Pollution by Garbage from Ships (entered into force 31 December 1988). • Annex VI Prevention of Air Pollution from Ships (entered into force 19 May 2005).

Table A.3: Environmental Impact Assessment

Regulatory Body	Legislation	Summary of Requirements

DECC	Council Directive on the Assessment of the Effects of Certain Public and Private Activities on the Environment - 85/337/EEC (the EIA Directive) as amended by Directives 97/11/EC, 2003/35/EC and 2009/31/EC.
	
	EC Directive 2014/52/EU, amending EC Directive 2011/92/EU on the assessment of the effects of certain public and private projects on the environment
		The EIA Directive (85/337/EEC) has been in force since 1985 and applies to a wide range of defined public and private projects, which are defined in Annexes I and II:
		Annex I: all projects listed in Annex I are considered as having significant effects on the environment and require a mandatory EIA. Typical projects include, for example:
		• Extraction of petroleum and natural gas for commercial purposes where the amount extracted exceeds 500 tonnes/day in the case of petroleum and 500,000 cubic metres/day in the case of gas.
		• Pipelines with a diameter of more than 800 mm and a length of more than 40 km:
		  ○ for the transport of gas, oil, chemicals;
		  ○ for the transport of carbon dioxide (CO_2) streams for the purposes of geological storage, including associated booster stations.
		  ○ Installations for storage of petroleum, petrochemical, or chemical products with a capacity of 200,000 tonnes or more.
		The EC Directive 2011/92/EU (as amended by Directive 2014/52/EU) revokes the 85/337/EEC and 97/11/EC Directives and amends the 2003/35/EC directive. The 2012/92/EU lists two classes of project to which the Directive applies: Annex 1 Projects for which environmental assessment (EA) is mandatory; and Annex 2 projects for which EA is discretionary. Under 2012/92/EU, oil and gas developments are listed as Annex I projects. Directive 2014/52/EU makes provision for improvements to the EIA procedure.

		Significant changes are also made to Annex 3 and 4, with a new Annex 2a detailing information that needs to be provided when determining whether projects listed in Annex II require an EIA. Member States are required to implement the provision of this Directive no later than 16th May 2017.

Table A.3: Environmental Impact Assessment (continued)

Regulatory Body	Legislation	Summary of Requirements
DECC	The Offshore Petroleum Production and Pipe-lines (Assessment of Environmental Effects) Regulations 1999 (as amended 2007)	These Regulations implement the EIA Directive with regard to the offshore oil and gas industry. The Regulations require an environmental impact assessment (EIA) and the associated public consultation document (Environmental Statement (ES)) to be submitted for certain projects, these are: • Developments which will produce 500 tonnes (approximately 3,750 barrels) or more per day of oil or 500,000 cubic metres or more per day of gas (not including well testing). • Pipelines of 800 mm diameter and 40 kilometres or more in length. Other activities are subject to a discretionary process where either an ES or a PETs permitting (seeking a Direction that an ES is not required) needs to be submitted. Typically this discretionary approval covers: • The drilling of all wells • Developments, either stand-alone or incremental, producing less than 500 tonnes of oil per day or 500,000 cubic metres of gas per day. • Construction of pipelines of less than 800 mm diameter and 40 kilometres in length.
	OSPAR Recommendation 2010/5 on assessments of environmental impact in relation to threatened and/or declining species and habitats	The purpose of this Recommendation is to support the protection and conservation of species and habitats on the OSPAR List of threatened and/ or declining species and habitats, through assessments of environmental impacts of human activities. When assessments of environmental impacts of human activities that may affect the marine environment of the OSPAR (Oslo and Paris Conventions) maritime area are prepared, Contracting Parties should ensure they take account of the relevant species and habitats on the OSPAR List of threatened and/ or declining species and habitats (OSPAR Agreement 2008/6).

Table A.4: Territorial Waters

Regulatory Body	Legislation	Summary of Requirements
-	Territorial Sea Act 1987 Territorial Waters Order	Defines the extent of the territorial sea adjacent to the British Islands.

Table A.5: Atmospheric Emissions

Regulatory Body	Legislation	Summary of Requirements
MCA	MARPOL 73/78 Annex VI the Prevention of Air Pollution from Ships	Annex VI is concerned with the control of emissions of ozone depleting substances, NOx, SOx, and VOCs and requires ships (including platforms and drilling rigs) to be issued with an International Air Pollution Certificate following survey. This annex sets limits on sulphur oxide and nitrogen oxide emissions from ship exhausts as well as particulate matter and prohibits deliberate emissions of ozone depleting substances. Emissions arising directly from the exploration, exploitation and associated offshore processing of seabed mineral resources are exempt from Annex VI, including the following: • emissions resulting from flaring, burning of cuttings, muds, well clean-up emissions and well testing; • release of gases entrained in drilling fluids and cuttings; • emissions from treatment, handling and storage of reservoir hydrocarbons; and • emissions from diesel engines solely dedicated to the exploitation of seabed mineral resources.
DECC	The National Emission Ceilings Regulations 2002	These regulations transpose the EC Directive on national emission ceilings for certain atmospheric pollutants 2001/81/EC into UK law and set national ceilings and a requirement for the development of a reduction programme for SOx, NOx and VOCs. They set out the UK government commitment for achieving a reduction of atmospheric emissions by 2010 and thereafter not to exceed the amounts specified in the Schedule of that pollutant.
	The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 (as amended 2010) Directive 2012/33/EU (amending Directive 1999/32/EC)	These regulations implement Annex VI of MARPOL (the International Convention for the Prevention of Pollution from Ships 73/78) in the UK. The 2010 Amendments primarily implement provisions concerning the sulphur content of marine fuels contained in Council Directive 1999/32/EC. The Directive sets maximum sulphur content for fuel including heavy fuel oil; and gas oil including marine fuel.
	Climate Change Act 2008 Climate Change (Scotland) Act 2009	The Act sets up a framework for the UK to achieve its long-term goals of reducing greenhouse gas emissions and to ensure actions are taken towards adapting to the impact of climate change. The Act enables a number of elements, including amongst others; setting medium and long-term emissions reduction targets in statute, introduction of a system of carbon budgeting which constrains the total amount of emissions in a given time period, a new reporting framework for annual reporting of the UK's greenhouse gas emissions, creation of an independent advisory body (the Committee on Climate Change). As a result of the Act and the 2009 Order, the current legally-binding targets for the net UK carbon account are: 34% reduction by 2020 and 80% reduction by 2050, against a 1990 baseline.

Table A.5: Atmospheric Emissions (continued)

Regulatory Body	Legislation	Summary of Requirements
DECC	Offshore Combustion Installations (Prevention and Control of Pollution) Regulations 2001 as amended by: Energy Act 2008 (Consequential Modifications) (Offshore Environmental Protection) Order 2010) EU Emissions Trading Scheme (EU Directive 2003/87/EC) UK Emissions Trading Scheme as amended Offshore Combustion Installations (Prevention and Control of Pollution) (Amendment) Regulations 2007 EC Directive 2010/75/EU (Industrial Emissions Directive)	These regulations implement Council Directive 96/61/EC concerning integrated pollution prevention and control (IPPC) in the context of offshore oil and gas combustion installations. The aim of IPPC is to consider environmental impacts holistically and to achieve a higher level of environmental protection. The Regulations apply only to combustion installations with a combined rated thermal input exceeding 50 MW(th) and a PPC Permit will be required in order to operate a qualifying offshore installation. The permit will be granted with conditions that include provisions based on best available techniques, emission limits, and monitoring requirements. The 2007 Amendment Regulations implement the amendments made to EC Directive 96/61 by the Public Participation Directive 2003/35/EC and bring in tighter requirements for public consultation as part of the permit application process. The Council Directive 96/61/EC is now replaced by the Industrial Emissions Directive (EC Directive 2010/75/EU). However the new directive has not yet been implemented in the UK. The Industrial Emissions Directive came into force on 6 January 2011 and merges seven directives into one including the Integrated Pollution Prevention and Control (IPPC) Directive and Large Combustion Plant (LCP) Directive. The main thrust of the directive is to increase the use of BATs, an obligation to ensure that industrial operators use the most cost-effective techniques to achieve a high level of environmental protection. Member States have 2 years in which to implement the Directive into national legislation.
	EU Regulation 517/2014 on Fluorinated Greenhouse Gases The Fluorinated Greenhouse Gases Regulations 2009	The objective of the EU Regulation is to reduce the emissions of fluorinated greenhouse gases(F-gas) including hydrochlorofluorocarbons (HCFCs), perfluorocarbons and sulphur hexafluoride as covered by the Kyoto Protocol. EU Regulation 517/2014 came into force in 2014, apply in UK from 1 January 2015, and repealed EU Regulation 842/2006 to cut F-Gas emissions. These gases have been developed to replace ozone depleting substances such as chlorofluorocarbons and HCFCs but are long-lived powerful greenhouse gases. The Regulations include requirements on the leakage detection and labelling requirements of systems such as refrigeration systems, air-conditioning units and heat pumps that use these gases. Fluorinated gases are also used for fire fighting offshore. The UK regulations detail the training and qualifications for those who work with F-Gas and provide powers for enforcement of the EU regulation.
	Regulation (EC) 1005/2009 on substances that deplete the ozone layer Environmental Protection (Controls on Ozone-Depleting Substances Regulations 2011 The Ozone –Depleting Substances (Qualifications) Regulations 2009	The EU regulation is the primary regulation and details the compliance requirements in relation to the production, impact, export, placing on the market, recovery, recycling, reclamation and destruction of substances that deplete the ozone layer. The 2011 regulations give DECC the power to enforce the requirements of the EU regulation and the 2009 regulations detail the qualifications required by those working with Ozone depleting substances.

Table A.5: Atmospheric Emissions (continued)

Regulatory Body	Legislation	Summary of Requirements
	Directive 2003/87/EC of the European Parliament and the Council of 13 October 2003 establishing a scheme for greenhouse gas emission allowance trading within the Community and amending Council Directive 96/61/EC. The Greenhouse Gas Emissions Trading Scheme Regulations SI 2012/3038 The Carbon Accounting Regulations 2009	The European Union Emissions Trading Scheme (EU ETS) is one of the primary drivers for reducing carbon dioxide emissions within the EU by introducing a cost element. A permit to emit greenhouse gases (at present only carbon dioxide) must be obtained for qualifying installations – for the upstream oil & gas industry, this applies to stationary installations with a combined rated thermal input of >20 MW(th) and flaring. In practice this generally means that production platforms will require a permit whereas mobile drilling units are at present exempt. The Regulations are being implemented in stages; Phase I has been implemented and Phase II is currently in operation. Phase III will be in force during 2013-2020. Regulations SI 2012/3038, which came in force on 1 January 2013, replace the Greenhouse Gas Emissions Trading Scheme Regulations 2005. These Regulations implement the Directive 2003/87/EC.
DECC	The Greenhouse Gas Emissions Data and National Implementation Measures Regulations 2009 EU Decision 2011/278/EU on determining the transitional EU wide rules for the harmonised free allocation of emission allowances in accordance with Article 10a of the EU ETS Directive Commission Regulation (EU) No: 1210/2011 concerning the auctioning of EU ETS allowances Commission Regulation (EU) No: 1193/3011 concerning the establishment of a single Union wide EU ETS Registry	Allowances for existing operators under Phase III have been notified following an extensive data collection and benchmarking exercise. As of 30 June 2011, all other applicants will now need to apply through the New Entrants Reserve (NER). Installations that have entered under Phase I or Phase II will already have new allocations issued under Phase III. There are two phases to NER applications: • Phase 1 - before "normal" operations - allocations based on independently verified emissions; and • Phase 2 - after start of "normal" operations - allocations based on average of two months of highest activity in a 90 day period after start of "normal" operations x 12. Normal operations are defined as a continuous 90 day period of operating at a minimum of 40% of design capacity.

Table A.6: Access to Environmental Information and Public Participation

Regulatory Body	Legislation	Summary of Requirements
DECC	Directive 2003/4/EC of the European Parliament and of the Council of 28 January 2003 on public access to environmental information and repealing Council Directive 90/313/EEC The Environmental Information (Scotland) Regulations 2004	This Directive transposes the first pillar of the Aarhus convention on access to information into EU legislation. This Directive requires all public authorities to provide members of the public with access to environmental information, and to actively disseminate the environmental information they hold. The information must be provided to any person at their request, without them having to prove an interest and at the latest within two months of the request being made. The Directive is implemented in Scotland by The Environmental Information (Scotland) Regulations 2004.
	Public Participation Directive (PPD) 2003/35/EC	Provides for public participation in the preparation of environmental plans, programmes and projects with significant environmental impacts. See section on environmental impact assessment.

Table A.7: Conservation and Biodiversity

Regulatory Body	Legislation	Summary of Requirements
DECC, JNCC, SNH, DEFRA	The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 as amended	These Regulations make provision for implementing the Birds Directive and Habitats Directive in relation to marine areas where the United Kingdom has jurisdiction beyond its territorial sea. The Regulations make provision for the selection, registration and notification of sites in the offshore marine area (European Offshore Marine Sites) and for the management of these sites. Competent authorities are required to ensure that steps are taken to avoid the disturbance of species and deterioration of habitat in respect of the offshore marine sites and that any significant effects are considered before authorisation of certain plans or projects. Provisions are also in place for issuing of European Protected Species (EPC) licences for certain activities and for undertaking monitoring and surveillance of offshore marine sites. The Amendment Regulations make various insertions for new enactments (e.g. new Birds Directive) and also devolve certain powers to Scottish Ministers. Most recent amendments to the 2007 and 2010 regulations are: The Conservation (Natural Habitats, &c.) Amendment (Scotland) Regulations 2012 The Conservation of Habitats and Species (Amendment) Regulations 2012.
	The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 as amended 2007	The Secretary of State set out these Regulations to consider whether a "Habitats Regulatory Assessment" should be undertaken prior to granting a licence under the Petroleum Act 1998. Habitats Regulatory Assessment is the formal assessment by the Competent Authority of the impacts of a plan or project on the integrity of (a) Natura 2000 site(s). Habitats Regulatory Assessment is a process separate from the EIA requirements, but which should run alongside and concurrently with the EIA requirements. The 2007 amendments also extend this requirement to all UK waters. These regulations implement European Directives for the protection of habitats and species in relation to oil and gas activities carried out in whole or in part on the UKCS. In particular these are the Council Directive 92/43 on the conservation of natural habitats, wild fauna and flora and Council Directive 79/409 on the conservation of wild birds. The 2007 amendments extend the requirements to all UK waters.
	Marine and Coastal Access Act 2009 Marine (Scotland) Act 2010 Marine Licensing (Exempted Activities) (Amendment of the Marine Licensing (Exempted Activities) Order 2013 (SI 2013/526)	These two Acts introduce a framework for the development of a new planning system for the marine area and ensure greater protection for the marine environment and biodiversity. However, oil and gas activities are generally exempted from the Act(s) since an environmental regime/regulator is already in place under DECC. The Act(s) will apply to a number of activities e.g: removal of materials from the seabed (including structures), deposit of materials during decommissioning, disturbance of the seabed, use of explosives and installation of certain types of cables. DECC will retain responsibility for offshore installation enforcement activities, and the Marine Management Organisation & Devolved Authorities will take responsibility for "at sea" enforcement of oil and gas activities. The Amendment Order details a number of activities exempt from the requirement for a MCAA licence.

Table A.8: Emergency Response

Regulatory Body	Legislation	Summary of Requirements
DECC	The Offshore Installations (Emergency Pollution Control) Regulations 2002	The Regulations give the Representative of the Secretary of State for Energy and Climate Change (SOSREP) powers to intervene in the event of an incident involving an offshore installation where there is, or may be, a risk of significant pollution, or where an operator is failing or has failed to implement effective control and preventative operations.
	The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended 2011)	Under these Regulations, it is an offence to make an unlawful release of oil, i.e. a release of oil other than in accordance with the permit granted under these Regulations for oily discharges (e.g. produced water etc.). However, it will be a defence to prove that the contravention arose because of something that could not have been reasonably prevented, or that it was due to something done as a matter of urgency for the purposes of securing the safety of any person. PON 1 reporting.
	Merchant Shipping Act 1995	The Merchant Shipping Act 1995 implements in the UK the Oil Pollution Preparedness, Response and Co-operation Convention (OPRC) Convention. The aim of the OPRC Convention is to increase the level of effective response to oil pollution incidents and to promote international co-operation to this end. The Convention applies to ships and offshore installations and requires operators to have in place Oil Pollution Emergency Plans (OPEP), which are approved by the body that is the National Competent Authority for the Convention.
	The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation) Regulations 1998 (as amended 2001)	The Merchant Shipping OPRC Regulations 1998 introduce into UK law the oil spill planning requirements and legal oil spill reporting requirements of the OPRC Convention. Every offshore installation and oil-handling facility must have an approved OPEP setting out arrangements for responding to incidents that cause or may cause marine pollution by oil, with a view to preventing such pollution or reducing or minimising its effect.

Table A.9: Environmental Liability

Regulatory Body	Legislation	Summary of Requirements
SEPA, MS and SNH	Directive 2004/35/EC of the European Parliament and the Council of 21 April 2004 on environmental liability with regard to the prevention and remedying of environmental damage.	The Environmental Liability Directive (ELD) enforces strict liability for prevention and remediation of environmental damage to 'biodiversity', water and land from specified activities and remediation of environmental damage for all other activities through fault or negligence. The Directive defines "environmental damage" as damage to protected species and natural habitats, damage to water and damage to soil. Operators carrying out dangerous activities listed in Annex III of the Directive fall under strict liability (no need to proof fault). Operators carrying out other occupational activities than those listed in Annex III are liable for fault-based damage to protected species or natural habitats. The establishment of a causal link between the activity and the damage is always required. Affected natural or legal persons and environmental NGOs have the right to request the competent authority to take remedial action if they deem it necessary. The ELD was amended three times through Directive 2006/21/EC on the management of waste from extractive industries, through Directive 2009/31/EC on the geological storage of carbon dioxide and amending several directives, and through Directive 2013/30/EU on safety of offshore oil and gas operations and amending Directive 2004/35/EC. The amendments broadened the scope of strict liability by adding the "management of extractive waste" and the "operation of storage sites pursuant to Directive 2009/31/EC" to the list of dangerous occupational activities in Annex III of the ELD. The Offshore Safety Directive, containing an amendment to the ELD (extension of the scope of damage to marine waters), was adopted in June 2013.
	The Environmental Liability (Scotland) Regulations 2009 as amended 2011	These Regulations implement the EC Environmental Liability Directive in Scotland. The regulations oblige operators of certain activities to take preventative measures where there is an imminent threat of environmental damage, and to remediate any environmental damage caused by their activities.

Table A.10: Chemicals, drainage and oily discharges

Regulatory Body	Legislation	Summary of Requirements
DECC, Marine Scotland, CEFAS	The Offshore Chemicals Regulations 2002 (as amended 2011)	The Offshore Chemicals Regulations 2002 implement the OSPAR Decision (2000/2) and OSPAR Recommendations (2000/4 and 2000/5) introducing a Harmonised Mandatory Control System for the use and reduction of the discharge of offshore chemicals. The Regulations introduced a permit system for the use and discharge of chemicals offshore and include a requirement for site specific risk assessment. Chemicals used offshore must be notified through the Offshore Chemical Notification Scheme (OCNS) and chemicals are ranked by hazard quotient, using the Chemical Hazard Assessment and Risk management (CHARM) model. Applications for permits are made via the submission of the relevant TETs permit (i.e. chemicals for drilling: PON 15B; pipelines: PON 15C; production: PON 15D; decommissioning: PON 15E; and workovers and well interventions: PON 15F). Amendments in 2011 to the Offshore Chemicals Regulations and the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2010. The principal aim is to make unlawful unintentional releases of chemicals and oil that arise through accidents/ non-operational discharges by broadening accordingly the definitions of "offshore chemical" and "discharges" and incorporating a new concept of "release".
	Convention for the Protection of the Marine Environment of the North East Atlantic 1992 (OSPAR Convention) OSPAR Decision 2000/3 on the Use of Organic-Phase Drilling Fluids (OPF) and the Discharge of OPF-Contaminated Cuttings OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles.	The OSPAR Convention (in particular Annex III) is the main driver for reductions in oily discharges to the North Sea. The UK as a contracting party to the Convention is therefore obliged to implement any Decisions and Recommendations made by the Commissions. Certain decisions made under the earlier Paris Convention also still stand. OSPAR Decision 2000/3 that came into effect on 16 January 2001 effectively eliminates the discharge of organic phase fluids (OPF) (oil based (OBF) or synthetic based (SBF) drilling fluids) or cuttings contaminated with these fluids. Use of OPF is still allowed provided total containment is operated. The use of diesel-oil-based drilling fluids is prohibited. The discharge of whole OPF to the sea is prohibited. The mixing of OPF with cuttings for the purpose of disposal is not acceptable. The discharge of cuttings contaminated with OBF (including SBF) greater than 1% by weight on dry cuttings is prohibited. The use of OPF in the upper part of the well is prohibited. Exemptions may be granted by the national competent authority for geological or safety reasons. The discharge into the sea of cuttings contaminated with synthetic fluids will only be authorised in exceptional circumstances. Authorisations to be based on the application of BAT/ Best Environmental Practice (BEP). Best Available Techniques described within the Decision include recycling, recovery and reuse of muds. The OSPAR 2006/5 Recommendation sets out measures to reduce pollution from oil or other chemicals from cuttings piles.
	The Merchant Shipping (Prevention of Oil Pollution) Regulations 1996 (as amended)	These Regulations give effect to Annex I of MARPOL 73/78 (prevention of oil pollution) in UK waters and have been amended by the Merchant Shipping (Implementation of Ship-Source Pollution Directive) Regulations 2009 described above. They address oily drainage from machinery spaces on vessels and installations. The North Sea is designated a “Special Area”, within which the limit for oil in discharged water from these sources is 15 ppm. Vessels and installations are required to hold a valid UKOPP (UK Oil Pollution Prevention) or IOPP (International Oil Pollution Prevention Certificate). Vessels and drilling rigs are also required to hold a current, approved Shipboard Oil Pollution Emergency Plan (SOPEP) which is in accordance with guidelines issued by the Marine Environment Protection Committee of the International Maritime Organisation (IMO).

Table A.10: Chemicals, drainage and oily discharges (continued)

Regulatory Body	Legislation	Summary of Requirements
DECC, Marine Scotland, CEFAS	Merchant Shipping Act 1995 International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78	Arrangements for Survey and Certification Part VI of the Merchant Shipping Act, 1995 makes provision for the prevention of pollution from ships. It implements in the UK the requirements of the International Convention for the Prevention of Pollution from Ships (MARPOL) 73/78. MARPOL defines ships to include offshore installations and relevant provisions of MARPOL are applied to offshore installations. Annex I of MARPOL relates to prevention of oil pollution and has provisions for machinery space drainage that are applied to offshore platforms: Vessels of 400 GT or above (which includes a floating storage unit) are permitted to discharge processed water (i.e. Oily Drainage Water) from Machinery Space Drainage as long as the oil content without dilution, does not exceed 15 ppm of the oil in water.
	PARCOM Recommendation 86/1 of a 40 mg/l Emission Standard for Platforms	The PARCOM Recommendation 86/1 provision of a 40 mg/l performance standard for platforms is applicable, and remains in force for discharges of displacement water, drainage water and ballast water, which are not covered under MARPOL. The maximum concentration of dispersed oil must not exceed 100 mg/l at any time.
	The REACH Enforcement Regulations 2008	These enforce Regulation (EC) No 1907/2006 of the European Parliament and of the Council concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) which require chemical users to demonstrate the safe manufacture of chemicals and their safe use throughout the supply chain. Under REACH, the users of chemicals as well as their manufacturers and importers have a responsibility to ensure that the risks to both human health and the environment are adequately assessed.
	The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended 2011)	These Regulations replaced the Prevention of Oil Pollution Act 1971 ("POPA") and are a mechanism to continue implementation on the UKCS of OSPAR Recommendation 2001/1. Discharges of reservoir oil associated with drilling from a floating storage unit (FSU) must be covered by an OPPC Term Permit, whereas discharges from a production installation are covered by an OPPC Life Permit. Operators are required to regularly report actual oil discharge in order that adequate monitoring can be achieved. These regulations do not apply to those discharges regulated under the Offshore Chemicals Regulations 2002, the Merchant Shipping (Prevention of Oil Pollution) Regulations 1996 (as amended) or the Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008. Amendments in 2011, via the Offshore Chemicals Regulations and the Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2010 introducing new concept of "release " and " offshore installation" which encompasses all pipelines . The concentration of dispersed oil in produced water discharges as averaged over a monthly period must not exceed 30 mg/l, whereas the maximum permitted concentration must not exceed 100 mg/l at any time. The quantity of dispersed oil in produced water discharged must not exceed 1 tonne in any 12 hour period.

Table A.11: Waste handling and disposal

Regulatory Body	Legislation	Summary of Requirements
EA/ SEPA	International Convention for the Prevention of Pollution from Ships (MARPOL) 1973 Annex V, as amended	Annex V: Prevention of pollution by garbage from ships (entered into force December 1998). Deals with the different types of garbage and specifies the distances from land and the manner in which they may be disposed of. The Annex also designates Special Areas (including the North Sea) where the disposal of any garbage is prohibited except food wastes. The dumping of plastics at sea is also prohibited by this Annex.
	Environmental Protection Act 1990	This Act, and associated regulations, introduces a "Duty of Care" for all controlled wastes. Waste producers are required to ensure that wastes are identified, described and labelled accurately, kept securely and safely during storage, transferred only to authorised persons and that records of transfers (waste transfer notes) are maintained for a minimum of two years. Carriers and waste handling sites require licensing. This Act and associated Regulations brought into effect a system of regulation for "controlled waste". Although the Act does not apply to offshore installations, it requires operators to ensure that offshore waste is handled and disposed of onshore in accordance with the "Duty of Care" introduced by the Act.
	Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives. The Waste (Scotland) Regulations 2011	The European Parliament introduced a new Directive, 2008/98/EC, on waste and repealing certain Directives. The Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving efficiency of such use. The 2011 Scotland Regulations make a number of amendments to a variety of Scottish waste legislation to transpose aspects of Directive 2008/98/EC on waste into Scottish law.
	The Environment Protection (Duty of Care) Regulations 1991	Under these Regulations any person who imports, produces, carries, keeps, treats or disposes of Controlled Waste has a duty to take all reasonable steps to ensure that their waste is handled lawfully and safely. Special/ Hazardous Waste is a sub-category of Controlled Waste (see also Special Waste Regulations).
	The Controlled Waste Regulations 1992 (as amended)	This legislation does not strictly apply offshore. However, because the offshore disposal of garbage is prohibited then all wastes must be transferred to shore for disposal. Once onshore, the wastes must meet the requirements of onshore legislation when being disposed of. These regulations must therefore be considered offshore to allow onshore requirements to be met, for example the identification and appropriate documentation of these wastes. These regulations define household, industrial and commercial waste for waste management licensing purposes.
Marine Scotland	Food and Environment Protection Act 1985	A licence is required under FEPA for any waste disposal in the sea or under the seabed. However, the Deposits in the Sea (Exemptions) Order 1985 exempts from FEPA licensing the deposit on site or under the seabed of any chemicals and drill cuttings. However, export of cuttings to another field for re-injection will require a licence under FEPA.
SEPA	The Merchant Shipping (Implementation of Ship-Source Pollution Directive) Regulations 2009	These Regulations implement Directive 2005/35/EC of the European Parliament and of the Council of 7th September 2005 on ship-source pollution and on the introduction of penalties for infringements. The Directive aims to achieve better enforcement of the requirements of the International Convention for the Prevention of Pollution from Ships, 1973 (MARPOL 73), as modified by the Protocol of 1978 (MARPOL 73/78).

Table A.11: Waste handling and disposal (continued)

Regulatory Body	Legislation	Summary of Requirements
SEPA	The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008 (as amended 2010)	These Regulations implement the requirements of MARPOL 73/78 Annex IV in the UK and apply to vessels including fixed or floating platforms which operate in the marine environment and came into force on 01 February 2009. They lay out the requirements for sewage system surveys and certification and the requirements of sewage systems with an exception for fixed installations at a distance of more than 12 nautical miles from the nearest land. They also identify the requirements for a garbage management plan, garbage record books and prohibit the disposal of various types of garbage into the marine environment and define enforcement action. The 2010 Amendments correct drafting errors.
	The Special Waste Regulations 1996 as amended	These Regulations make provision for handling special waste and for implementing Council Directive 91/689/EEC of 12 December 1991 on hazardous waste. The Regulations require controlled wastes that are also considered to be special wastes because of their hazardous properties, to be correctly documented, recorded and disposed of at an appropriately licensed site. Whilst strictly speaking the Regulations do not apply offshore, waste consignments must be compliant as soon as the waste is offloaded at an onshore facility. In Scotland, The Special Waste Amendment (Scotland) Regulations 2004 amend the Special Waste Regulations 1996. They implement the revised European hazardous waste list, (incorporated into the European Waste Catalogue). They introduced the new consignment note, segregation, packaging and labelling requirements. In England and Wales the Special Waste Regulations 1996 were repealed by The Hazardous Waste (England and Wales) Regulations 2005.

Table A.12: Low specific activity (LSA) contaminated waste (sand, sludge and scale) and Radioactive waste

Regulatory Body	Legislation	Summary of Requirements
SEPA	Radioactive Substances Act 1993 The Environmental Permitting 2010 (England and Wales) Regulations (as amended 2015) The Radioactive Substances Act 1993 Amendment (Scotland) Regulations 2011	Onshore and offshore storage and disposal of naturally occurring radioactive materials (NORM) is regulated under the Radioactive Substances Act. Operators are required to hold, for each relevant installation, an Authorisation to store and dispose of radioactive waste such as low specific activity scale (LSA) which may be deposited in vessels and pipework. The authorisation specifies the route and methods of disposal. Records of disposal are required. The offshore use, storage and disposal of radioactive sources are regulated under the same legislation. A Registration Certificate is required to keep; transport and use sources and records must be kept. Additionally, different radionuclides have different activity thresholds over which the containing sources qualify as a High Activity Sealed Source (HASS). As of January 2008, and if applicable, HASS records must be reported to SEPA or the EA and maintenance of an inventory is required. The Radioactive Substances Act 1993 has been superseded by the Environmental Permitting (England and Wales) Regulations 2010 (as amended in 2015) in England and Walesbut it has remained in place in Scotland. However, in Scotland there have also been consultations regarding a future exemptions regime under The Radioactive Substances Act 1993. These consultations have resulted in the Radioactive Substance Exemption (Scotland) Order 2011. This order will revoke and replace a series of exemption orders (in Scotland) made under the Radioactive Substances Act 1993 (“the Act”) and its predecessor (the Radioactive Substances Act 1960) in order to rationalise the current system of exemptions and bring it into line with the structure and terminology used in the Basic Safety Standards Directive.

Table A.13: Environmental Management Systems

Regulatory Body	Legislation	Summary of Requirements
DECC	OSPAR Recommendation 2003/5 to Promote the Use and Implementation of Environmental Management Systems by the Offshore Industry	All Operators controlling the operation of offshore installations on the UKCS are required to have in place an independently verified Environmental Management System designed to achieve: the environmental goals of the prevention and elimination of pollution from offshore sources and of the protection and conservation of the maritime area against other adverse effects of offshore activities and to demonstrate continual improvement in environmental performance. OSPAR recognises the ISO 14001: 2004 & EMS international standards as containing the necessary elements to fulfil these requirements. All operators are also required to provide a public statement of their environmental performance on an annual basis.

Table A.14: Licensing

Regulatory Body	Legislation	Summary of Requirements
DECC Marine Scotland	Petroleum Act, 1998 as amended The Petroleum Licensing (Exploration and Production) (Seaward and Landward Areas) Regulations 2004 (as amended 2006) The Petroleum Licensing (Production) (Seaward Areas) Regulations 2008	These Regulations consolidate with amendments the provisions of the Petroleum (Production) Regulations 1982 (as amended) in relation to (a) applications to the Secretary of State for petroleum production licences in respect of seaward areas and (b) applications to the Secretary of State for petroleum exploration licences in respect of seaward areas and landward areas below the low water line. This Act vests all rights to the nation's petroleum resources to the Crown and provides the basis for granting licences to explore for and produce oil and gas. Production licences grant exclusive rights to the holders to “search and bore for and get petroleum” in specific blocks. Licences generally contain a number of environmental restrictions and conditions. Under the terms of a Licence, licence holders require the authorisation of the Secretary of State prior to conducting activities such as installing equipment or drilling of wells in the licence area. Consent to flare or vent hydrocarbons is also required from DECC under the terms of the Model Clauses incorporated into Production Licences. Licence conditions will include environmental issues e.g. time constraints in sensitive areas. The model clauses of the licence require the licensee to appoint a fisheries liaison officer.
	Marine & Coastal Access Act 2009	The Marine & Coastal Access Act provides the legal mechanism to help ensure clean, healthy, safe, productive and biologically diverse oceans and seas by putting in place a new system for improved management and protection of the marine and coastal environment.

Table A.15: Ballast water

Regulatory Body	Legislation	Summary of Requirements
MCA	International Convention for the Control and Management of Ships' Ballast Water and Sediments (BWM) – adopted 2004	Objective to prevent, minimise and ultimately eliminate the transfer of harmful aquatic organisms and pathogens though control and management of ships' ballast water and sediments. Helsinki and OSPAR Commissions General Guidance on the Voluntary Interim has set out an application of the D1 Ballast Water Exchange Standard. Under this regulation, all tankers > 150 GRT and all ships > 400 GRT in the UK are required to have in place United Kingdom Oil Pollution Prevention Certificate (UKOPP) or IOPP Certificate and Ballast Water Exchange Management plan. It is required all vessels entering the North East Atlantic to exchange the ballast water at least 200 nautical miles from the nearest land and at least 200 metres deep.

Table A.16: Transboundary Impacts

Regulatory Body	Legislation	Summary of Requirements
DECC	Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991)	The 1991 UNECE Convention on Environmental Impact Assessment in a Transboundary Context (the Espoo Convention) requires any country that has ratified the convention to consider the transboundary environmental effects of industrial projects and activities, including offshore hydrocarbon exploration and productions activities. The Convention requires that if the activity is found to cause a significant adverse transboundary impact then the party undertaking the activity shall, for the purpose of ensuring adequate and effective consultations, notify any potentially affected country as early as possible.

Table A.17: Location of Structures

Regulatory Body	Legislation	Summary of Requirements
DECC	Coast Protection Act 1949 (as extended by the Continental Shelf Act 1964) Energy Act 2008	This Act provides that where an obstruction or danger to navigation is caused, or is likely to result, the prior written consent of the Secretary of State is required for the citing of the offshore installation - whether mobile or permanent - in any part of the UK designated areas of the Continental Shelf. In practice, this means that consent must be obtained for each drilling operation and for all offshore production facilities. The issuing of 'consent to locate' under the Coast Protection Act Regulations 1949 section 34, part II, to an individual or organisation and provides an indication that impacts have been considered with respect to navigation, the local habitat within the proposed area and that no significant impacts would occur as a consequence of the proposed offshore installation The 1949 Act was extended by Section 4 (1) of the Continental Shelf Act 1964 to all parts of the UK Continental Shelf where oil and gas exploration and development is taking place. The provisions of the Coast Protection Act were transferred to the Energy Act 2008 Part 4A by the Marine Coastal Access Act 2009 (MCAA) and Marine Scotland Act 2010 (MSA) to cover navigation considerations relating to exempted exploration or production/ storage operations. Consent to locate provisions of the Energy Act Part4A came into force in April 2011. On 11th October 2012 DECC launched its consultation on the Part 4A consenting provisions. Section 77 of the MCAA excludes the vast majority of offshore oil and gas operations and carbon dioxide storage operations controlled under The Petroleum Act 1998 (PA) or The Energy Act 2008 (EA). To maintain the Consent to Locate provisions for these excluded operations, Section 314 of the MCAA created a new Part 4A of the EA, transferring the provisions of Section 34 of the CPA to the EA and transferring regulatory competence from DfT to DECC. On 5th June 2013 DECC published its response to consultation on the Part 4A consenting provisions. Full implementation of the Consent to Locate (CtL) regime under Part 4A of the EA commenced on Friday 7th June 2013.
	Continental Shelf Act 1964	This act extends the UK government's right to grant licences to explore and exploit the UKCS.
	The Continental Shelf (Designation of Areas) (Consolidation) Order 2000	This Order consolidates the various Orders made under the Continental Shelf Act 1964 which have designated the areas of the continental shelf within which the rights of the United Kingdom with respect to the sea bed and subsoil and their natural resources are exercisable
	Marine and Coastal Access Act 2009 and Marine (Scotland) Act 2010	The MCAA and Marine (Scotland) Act replaced and merged the requirements of FEPA Part II (deposits to the sea) and the Coast Protection Act 1949 (navigation). The licensing provisions of these Acts enter into force in April 2011. See also Marine & Coastal Access Act 2009 & The Marine (Scotland) Act 2010.

Intentionally blank page

APPENDIX B: NON-SIGNIFICANT IMPACTS

This Appendix provides the justification for the environmental risks that were considered to be "low" during the Environmental Risk Assessment (Chapter 5) and were excluded from further investigation within the main Environmental Statement.

Table B.1: Justification for the exclusion of non-significant (low risk) environmental effects from further investigation in the decommissioning EIA: Surface-laid seabed infrastructures.

Aspect	Environmental Impact or Risk	Proposed Control and Mitigation	Justification
Surface laid seabed infrastructure: Planned operations			
Unlatch towheads and midline structure and retrieval to vessel Retrieval of spools, mattresses and wellheads Removal and retrieval to vessel of gas import pipeline from Beryl	• Disturbance to sediments and potential for debris to remain on the seabed. • Slight deterioration in water quality around point of discharge. • Where materials are disposed of, potential use of landfill space and loss of resources. • Temporary loss of access to fishing grounds. • Temporary potential impedance to navigation.	• Post-decommissioning a debris survey will be undertaken to remove any objects remaining on the seabed.	• The area of seabed that will be disturbed as a result of decommissioning activities will be localised and very small. Re-colonisation will occur after operations had ceased. • During transportation operations there will be a temporary loss of a very small area for fishing and navigation. However, the potential area that will be affected by the physical presence of the vessels will be insignificant and the effects will be fleeting.
Surface laid seabed infrastructure: Planned End-points			
Re-use or recycling of towheads, midline structure and spools	• Gaseous emissions during recycling • Reuse beneficial to other commercial users of the sea and removes the impact of gaseous emissions during recycling. • Temporary disruption to local communities and other commercial users of the land.	• Materials are re-used where possible	• Strict compliance with legislation on wastes and emissions. • All socio-economic impacts will be temporary.

Aspect	Environmental Impact or Risk	Proposed Control and Mitigation	Justification
Surface laid seabed infrastructure: Planned End-points			
Mattresses not re-used or recycled go to landfill	• Where materials are disposed of, use of landfill space and loss of resources. • Effect on local land and potentially freshwater resources • Temporary disruption to local communities and other commercial users of the land.	• Use of designated licensed sites only • Re-use or recycle where possible	• Minor quantity of material expected to go to landfill. • Strict compliance with legislation on wastes and emissions. • All socio-economic impacts will be temporary.
Surface laid seabed infrastructure: Unplanned operations			
Unrecovered large debris or dropped objects remain on the seabed	• Disturbance to seabed, water quality and benthos. • Potential obstruction to commercial fishing and other commercial users of the sea.	• Adherence to lifting and handling procedures and use of certified equipment for lifting. • Requirement to retrieve major items of debris from the seabed after operations, in compliance with relevant legislation.	• Major items will be recovered from the seabed therefore no long term impact would be anticipated. • Loss of individual hand-tools and other minor items of equipment will not constitute a threat to species, habitats or fishing.
Loss of contaminated water during operations	• Some associated deterioration of water quality. • Sea mammals may be also partially disturbed.	• All chemicals will be risk-assessed and presented in the appropriate permit for statutory approval from the DECC. • Chemicals will be selected in order to minimise hazards to the environment in accordance with Offshore Chemicals Regulations 2002 (as amended).	• Chemicals will have been approved by the DECC and risk assessments will indicate the potential for any environmental impact. • Discharges will be rapidly dispersed and diluted in the offshore environment and will not be expected to significantly impact the benthos, water column or fish. • The quantity used will be minimised as far as practicable.
Spillage of chemicals	• Some associated deterioration of water quality. • Sea mammals may be also partially disturbed.	• All chemicals will be risk-assessed and presented in the appropriate permit for statutory approval from the DECC. • Chemicals will be selected in order to minimise hazards to the environment in accordance with Offshore Chemicals Regulations 2002 (as amended).	• Chemicals will have been approved by the DECC and risk assessments will indicate the potential for any environmental impact. • Discharges will be rapidly dispersed and diluted in the offshore environment and will not be expected to significantly impact the benthos, water column or fish. • The quantity used will be minimised as far as practicable.

Table B.2: Justification for the exclusion of non-significant (low risk) environmental effects from further investigation in the decommissioning EIA: Leaving the buried pipeline bundles *in place*.

Aspect	Environmental Impact or Risk	Proposed Control and Mitigation	Justification
Leaving the buried pipeline bundles in place: Planned End-points			
Corrosion of pipelines and release of metals and pipeline contents	• Deterioration of sediment structure and water quality around the pipeline. • Potential effects on marine benthos and sediment chemistry.	• Pipeline ends will be buried in place preventing the release of pipeline contents into the marine environment	• The effects of leaving the pipeline in place will be long-term but will have a negligible impact on sediment and water column quality.
Leaving the buried pipeline bundles in place: Unplanned End-points			
Pipeline bundles not fully buried/ exposed as a result of fishing activity	• Potential obstruction to commercial fishing	• Owing to the rocky seabed conditions in the Leadon area; it is likely that any fishing vessels would employ rock hopper gear. This type of fishing equipment reduces the potential for snagging on subsea obstructions.	• Proposed mitigation evaluated according to discussions with SFF

Intentionally blank page

APPENDIX C: IOP (2000) ENERGY AND FUEL REQUIREMENTS

Table C.1: Manufacturing and recycling energy requirement data (IoP,2000)

Material	Energy to manufacture from raw material (GJ/tonne)	Energy to recycle (GJ/tonne)
Standard Steel	25	9
Copper	100	25
Concrete	1	-

Intentionally blank page

APPENDIX D: ATMOSPHERIC DISPERSION MODELLING

The model is an analytical model based on the Gaussian diffusion equation. The Gaussian element refers to the observation that the concentration of a gas released from a point follows an approximate normal distribution perpendicular to the centre line of the plume (Davis and Cornwell, 1991).

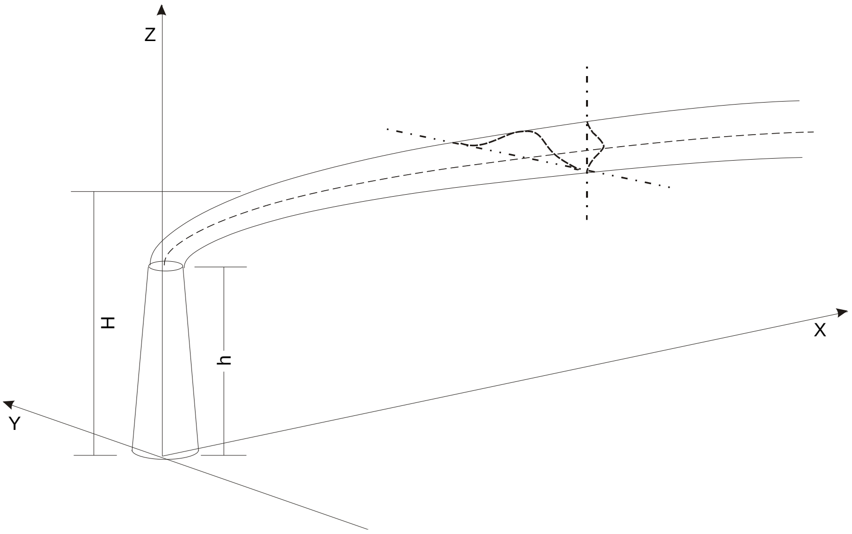


Figure D.1: Plume Model based on Davis and Cornwell (1991).

The concentration along the centre line is inversely proportional to the distance from the source although very close to the source the concentration is decreased due to plume rise. Thus, a skewed concentration curve is characteristic of this sort of model. The governing equation is:

$$X(x,y,0,H) = \left[\frac{Q}{\pi s_y s_z u}\right]\left[\exp\left[-\frac{1}{2}\left(\frac{y}{s_y}\right)^2\right]\right]\left[\exp\left[-\frac{1}{2}\left(\frac{H}{s_z}\right)^2\right]\right]$$

where *X(x,y,0,H)* = downwind concentration at ground level, g/m^3

Q = emission rate of pollution, g/s

s_y, s_z = plume standard deviations, m

u = wind speed, m/s

The basic Gaussian diffusion equation has the following assumptions:

- Atmospheric stability, that is the amount of mechanical mixing in the air, is uniform throughout the layer into which the gas stream is discharged (normally the boundary layer).
- Turbulent diffusion is random and therefore the dilution of the contaminated gas stream in both the vertical and horizontal direction can be described by the Gaussian or normal equation.
- The gas stream is released into the atmosphere at a distance above ground level that is equal to the stack height plus the plume rise (caused by convection if the released gas is hotter than the ambient temperature).

- The degree of dilution is inversely proportional to the wind speed (although wind speed data is not actually used within this model).
- Pollutant material that reaches the ground is totally reflected back into the atmosphere.

The calculation of H is obtained from adding ΔH and h via Holland's formula:

$$\Delta H = \frac{v_s d}{u}\left[1.5 + \left(2.68 \times 10^{-2}(P)\left(\frac{T_s - T_a}{T_s}\right)d\right)\right]$$

where v_s = stack velocity, m/s

d = stack diameter

P = Pressure, kPa

T_s = stack temperature, K

T_a = air temperature, K

Specific assumptions for the modelling of the atmospheric emissions produced from power generation and testing are:

Physical Parameters

- Height of discharge (h) 50 m above LAT (taken to represent ground level).
- Flare diameter (d) of 0.762 m.
- Temperature of (T_s) is 200 °C or 473 K.

Atmospheric Conditions

- Wind speed (u) of 10 m/s.
- Temperature (T_a) is 15 °C or 288 K.
- Pressure (P) is 95.0 kPa.
- Overcast conditions (neutral stability).

Discharge Characteristics

<u>Power Generation:</u>

- Maximum flare rate of 15 tonnes per day of diesel.
- Molecular weight of gas of 22.
- Emission factors from UKOOA (1999).

<u>Flaring during Well Clean-up:</u>

- Maximum flare rate of 1,162 tonnes per day of gas.
- Molecular weight of gas of 17.
- Emission factors from UKOOA (1999).