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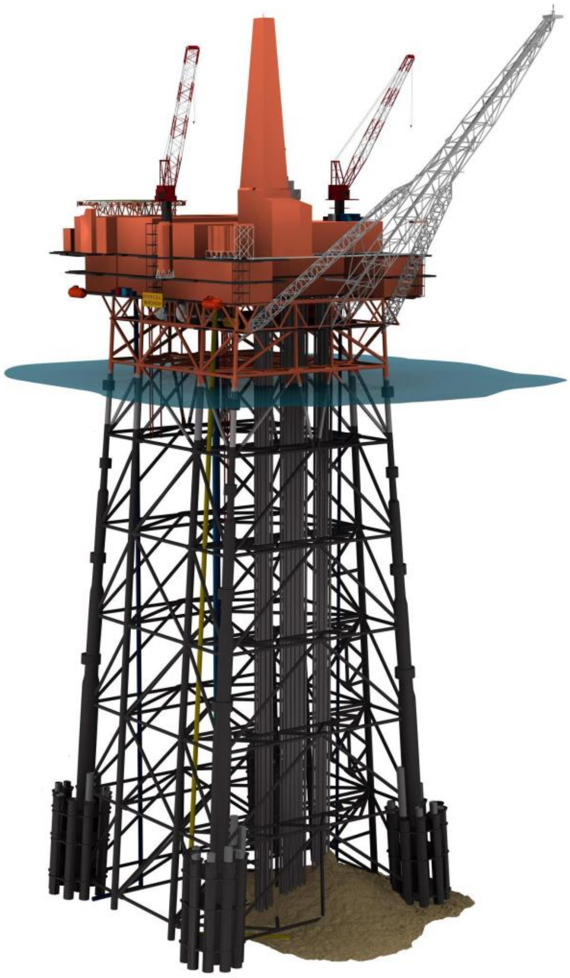

Murchison Facilities Decommissioning Environmental Statement

Revised Post-Statutory Consultation

November 2013

MURDECOM-BMT-EN-REP-00198

Note to Readers - November 2013

The post-statutory consultation version of the Environmental Statement incorporates clarifications and additional information requested by DECC in respect of several parts of Chapter 4 regarding the naming of PL186, now referred to as the SSIV Murchison Control Umbilical and for which further detail has been added, and the addition of information on the densitometers, umbilical and bundles in Tables 4.4, 4.5, and 4.7 respectively.

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ABBREVIATIONS

A	
AHV	Anchor Handling Vessel
Al	Aluminium
AoS	Areas of Search
APE	Alkylphenol Ethoxylates
As	Arsenic
AUMS	Aberdeen University Marine Studies
AWJ	Abrasive Water Jetting
B	
Ba	Barium
BAC	Background Assessment Concentrations (also referred to as Background Assessment Criteria)
BAT	Best Available Technique
$BaSO_4$ / Barite	Barium Sulphate
BC	Background Concentrations
BEP	Best Environmental Practice
BERR	Department of Business Enterprise and Regulatory Reform (now DECC)
BOD	Biological Oxygen Demand
BTA	Buoyancy Tank Assembly
C	
CA	Comparative Assessment
CCS	Carbon Capture and Storage
Cd	Cadmium
CEFAS	Centre for Environment, Fisheries and Aquaculture Studies
CH_4	Methane
CHARM	Chemical Hazard and Risk Management
CNRI	Canadian Natural Resources International
CO_2	Carbon Dioxide
CoP	Cessation of Production
Cr	Chromium
cSAC	candidate Special Area of Conservation
CSV	Construction Support Vessel
Cu	Copper
D	
dB	Decibel
DBT	Dibutyltin
DECC	Department of Energy and Climate Change, formerly BERR
DEFRA	Department of Environment, Food and Rural Affairs
DEMP	Decommissioning Environmental Management Plan
dSAC	draft Special Area of Conservation

DSV	Diving/Dive Support Vessel
DTI	Department of Trade & Industry
DWC	Diamond Wire Cutting
DWT	Deadweight Tonnage
E	
EAC	Environmental Assessment Criteria (formerly referred to as Ecotoxicological Assessment Criteria).
EC	European Commission
ED	Endocrine Disruptors
EDC	Engineering Down and Cleaning
EIA	Environmental Impact Assessment
EIF	Environmental Impact Factor
EMBF	Enhanced Mineral Oil Based Fluids
EMS	Environmental Management System
ERL	ER-Low
EPS	European Protected Species
ERT	Environment and Resource Technology Scotland Limited
ES	Environmental Statement
EU	European Union
EUNIS	European Nature Information System (http://eunis.eea.europa.eu/)
F	
FAO	Fish Aggregation Devices
Fe	Iron
FLTC	UK Fisheries Offshore Oil & Gas Legacy Trust Fund Limited
G	
GC	Gas Chromatography
GJ	Giga-Joule (10^9 Joules)
H	
HAZID	Hazard Identification Study
Hg	Mercury
HLV	Heavy Lift Vessel
HSE	Health and Safety Executive / Health, Safety and Environment(al)
Hz	Hertz
I	
ICES	International Council for the Exploration of the Seas
IMO	International Maritime Organization
IoP	Institute of Petroleum
ISO	International Organization for Standardization
ISS	Integrated Subsea Services Limited
J	
JNCC	Joint Nature Conservation Committee
K	
kg	Kilogram

km	Kilometre
KPI	Key Performance Indicator
kSm^3	Thousand Standard Cubic Metres
L	
LAT	Lowest Astronomical Tide
Ltd	Limited
LTOBF	Low Toxicity Oil Based Fluids
M	
m	Metre
MARPOL	The International Convention for the Prevention of Pollution from Ships
MBES	Multi-Beam Echo-Sounder
MBT	Monobutyltin
MCAA	Marine and Coastal Access Act
MFE	Mass Flow Excavation
MFWMP	Murchison Facilities Waste Management Plan
Mn	Manganese
MPA	Marine Protected Area
MSF	Module Support Frame
MSFD	Marine Strategy Framework Directive
MSV	Multi-support Vessel
N	
N/A	Not Applicable
ND	No Data
Ni	Nickel
NLGP	Northern Leg Gas Pipeline
n miles	Nautical Miles
NORM	Naturally Occurring Radioactive Materials
NOx	Nitrogen Oxides
NP	Nonylphenol
NRC	National Research Council
NSTF	North Sea Task Force
O	
OBM	Oil Based Muds
OP	Octylphenol
OPEP	Oil Pollution Emergency Plan
OPOL	Oil Pollution Operator’s Liability Fund
OPPC	Oil Pollution Prevention and Control
OSPAR	Oslo and Paris Convention
OSRL	Oil Spill Response Ltd.
OVI	Offshore Vulnerability Index
P	
P&A	Plug and Abandonment
PAF	Potentially Affected Fraction

PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCB	Polychlorinated Biphenyls
PEC	Predicted Environmental Concentration
Ph	Phytane
PL	Pipeline
PLANC	Permits, Licences, Authorisations, Notifications and Consents
PON	Petroleum Operations Notice
PPC	Pollution, Prevention and Control
Pr	Pristane
pSAC	possible Special Area of Conservation
PTS	Permanent Threshold Shift
Q	
R	
Ra	Radium
ROTV	Remotely Operated Towed Vehicle
ROV	Remotely Operated Vehicle
ROVSV	Remotely Operated Vehicle Support Vessel
S	
SAC	Special Area of Conservation
SAST	Seabirds at Sea Team
SCANS	Small Cetaceans in the European Atlantic and North Sea
SCI	Sites of Community Importance
SCU	Subsea Control Unit
SEA	Strategic Environmental Assessment
SEL	Sound Exposure Level
SHE	Safety, Health and Environment
SHEMS	Safety, Health and Environmental Management System
SMRU	Small Mammal Research Unit
SO_2	Sulphur Dioxide
SOPEP	Shipboard Oil Pollution Emergency Plan
Sox	Oxides of Sulphur
SPL	Sound Pressure Level
Sr	Strontium
SSB	Spawning Stock Biomass
SSIV	Subsea Isolation Valve
SSS	Side Scan Sonar
T	
t	Tonnes
Tba	Total Barium
TBT	Tributyltin
THC	Total Hydrocarbon Concentration
TOC	Total Organic Carbon

TTBP	Tri-Tert-Butylphenol
TTS	Temporary Threshold Shift
U	
UCM	Unresolved Complex Mixture
UK	United Kingdom
UKCS	United Kingdom Continental Shelf
UKDMAP	United Kingdom Digital Marine Atlas
UKOOA	United Kingdom Offshore Operators Association (now Oil and Gas UK Limited)
V	
V	Vanadium
VOC	Volatile Organic Compound
W	
WBM	Water Based Muds
WEEE	Waste Electrical and Electronic Equipment
WFD	Waste Framework Directive
WHO	World Health Organization
WMS	Waste Management Strategy
WWF	World Wildlife Fund
X	
Y	
Z	
Zn	Zinc

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GLOSSARY

A

B

Benthic fauna	Organisms that live on, associated with, or in the seabed sediments.
Benthos	See ‘Benthic Fauna’.
Biogeographic area	An area of the Earth as defined by the flora and fauna found there.
Block	A North Sea acreage sub-division measuring approximately 10 km x 20 km forming part of a quadrant, e.g. Block 21/05 is the 5th block of Quadrant 21.

C

CEFAS	The government agency which approves chemicals for offshore use (amongst other functions).
Cephalopods	A class of mollusc characterised by bilateral body symmetry, reduction and internalisation of the shell and modification of the foot into tentacles. Examples include squid, cuttlefish, octopus and nautilus.
Cetaceans	Aquatic mammals e.g. whales, dolphins and porpoises.
Controlled Waste	The term Controlled Waste is defined in Section 75(4) of the Environmental Protection Act 1990 as: “household, industrial and commercial waste or any such waste.” Not all radioactive waste is classified as controlled waste and may be regulated under The Radioactive Substances Act 1993 (explained below).
Copepods	Small crustaceans whose adult stage usually includes a single eye in the centre of the head. The free living marine species form a vital part of many marine food webs.
CPI	Carbon Preference Index. The ratio of the abundance of odd numbered *n*-alkanes over even numbered *n*-alkanes

D

dB_{ht}	A measure of the level of sound above the animal’s hearing threshold, or its “perception level”.
Demersal	The zone that is the part of the sea or ocean (or deep lake) comprising the water column that is near to (and is significantly affected by) the seabed.
Directive Waste	Directive Waste is defined in Article 1(a) of Council Directive 75/442/EEC as: “any substance or object which the producer or the person in possession of it discards or intends or is required to discard”. In determining if a substance or object has been discarded, the following question may be asked: “has the substance or object been discarded so that it is no longer part of the normal commercial cycle or chain of utility?”
DTI	Historically the regulatory authority for the offshore oil and gas industry, this agency has been dissolved and its energy-related responsibilities now fall to DECC.
Diatoms	A group of eukaryotic algae that secrete characteristic cell walls consisting of two separate halves with an overlap between them. Diatoms reproduce by binary fission and often exist as single cells, but some species form colonies of chains.
Dinoflagellates	A diverse group of eukaryotic algae that often have two protruding flagellae used for propelling and directing the cell.

Dispersant	An agent added to a suspension to improve the separation of particles. Dispersants added to spilled oil can help the oil break up into smaller droplets, increasing the exposed surface area and increasing the rate of degradation.
Dynamic Positioning	A system of sensors and thrusters on a vessel which allows it to maintain position using satellite telemetry to adjust thrusters' direction and power.
E	
Ecosystem	The physical environment and associated organisms that interact in a given area. There is no defined size for an ecosystem.
Environmental Impact Assessment	A process to identify and assess the impacts associated with a particular activity, plan or project.
Environmental Management System	A formal system which ensures that a company has control of its environmental performance.
Environmental Statement	A report setting out the findings of an assessment of a project's environmental impacts.
ERL	ER-Low (ERL) value is the lower tenth percentile of the data set of concentrations in sediments which were associated with biological effects.
European Protected Species	Species that are listed in Annex IV of the habitats directive, and are therefore protected from harm or disturbance by European law.
Epibiotic	An organism that lives on the surface of another organism.
Epifauna	Fauna inhabiting the surface of rocks, sediment or other fauna/flora.
European Commission	Body made up of commissioners from each EU country, responsible for representing the common European interest, with the power to instigate and apply changes in European law to all EU countries.
F	
Fauna	Animal life.
Flora	Plant life.
Frond mats	Mattress with buoyant fronds attached installed to reduce scour.
G	
H	
Hazardous Waste	Hazardous Waste is a term used in England, Wales and Northern Ireland for materials that have one or more of the hazardous properties described in the Hazardous Waste Directive 91/689/EEC.
I	
Infauna	Fauna that lives within sediments.
J	
K	
Krill	Shrimp-like marine animals found in all oceans of the world.
L	

M

Marine Scotland	A government consultee and a lead marine management organisation in Scotland, bringing together the functions of the Fisheries Research Services (Marine Scotland Science), the Scottish Fisheries Protection Agency (Marine Scotland Compliance) and the Scottish Government Marine Directorate.
Manifold	The branch pipe arrangement which connects the valve parts of multiple pipes.
Meroplankton	Plankton consisting of organisms at a certain life cycle stage (in particular larvae) that do not spend other stages of their lifecycles as plankton.
Motile	Organisms able to propel themselves from one place to another.
N	
Niche	An environment that is different from the surrounding area and that requires the organisms exploiting it to be specialised in ways not generally found in the surrounding area.
Non-Hazardous Waste	Material that does not fall within the classification of Special or Hazardous Waste.
Notice to Mariners	Admiralty Notice to Mariners containing all the corrections, alterations and amendments for the UK Hydrographic Office (UKHO) worldwide series of Admiralty Charts and Publications, published weekly as booklets, which are despatched directly from the UKHO.
O	
Organic	Compounds containing carbon and hydrogen.
P	
Pelagic	Any water in the sea that is not close to the bottom or near to the shore. Marine animals that live in the water column of coastal, ocean and lake waters, but not on the bottom of the sea or the lake.
Photic zone	In this context defined as the upper water column which receives enough light for photosynthesis to occur.
Phytoplankton	Planktonic organisms that obtain energy through photosynthesis.
Q	
R	
Radioactive Waste	The Radioactive Substances Act 1993 defines radioactive waste as: “waste which consists wholly or partly of: a) a substance or article which, if it were not waste, would be radioactive material; or b) a substance or article which has been contaminated in the course of the production, keeping or use of radioactive material, or by contact with or proximity to radioactive waste”. Where Radioactive Waste is below threshold levels stated in the Radioactive Substances Act 1993 and has one, or more, properties included in the Hazardous Waste Directive then this material is classified as Hazardous Waste and must be treated as such.
Risk	The combination of the probability of an event and a measure of the consequence.

S

Salinity	The dissolved salt content in this case of a body of water.
Sedentary	Organisms which are essentially fixed in one location, and unable to move.
Semi-diurnal	Occurring twice daily.
Special Waste	The term Special Waste is used in Scotland and is defined under the Special Waste Regulations 1996 which transposed the requirements of the European Hazardous Waste Directive (91/689/EEC). 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.
Stratification	Separation of a body of water into two or more distinct layers due to differences in density or temperature.
Sublittoral	The area between the low water line and the edge of the continental shelf.
Substrate	In this context, any surface which could provide a habitat for an organism to live, i.e. a rock outcropping or area of sand.
Surge	A rise in water level above that expected due to tidal effects alone; the primary causes are wind action and low atmospheric pressure.

T

THC	Total Hydrocarbon Concentration. The summed concentration of all the resolved/unresolved (i.e. UCM) aliphatic and aromatic hydrocarbons derived from biogenic and petrogenic sources.
Thermocline	An area in the water column where there is a rapid temperature change with increasing depth. This is due to stratification between warmer, well mixed, less dense water in the surface layer and deeper, colder water below.
Tie-Back	Tie-backs connect new oil and gas discoveries to existing production facilities.
TOC	Total Organic Carbon. The sum of all organic carbon in the sample.
Topography	The surface features of the seabed.
Transient	In this context, animals that tend to move through areas rather than stay in a given area for a long period of time.

U

UKCS	United Kingdom Continental Shelf. Waters in which the UK Government has jurisdiction over oil and gas activity.
Umbilical	Subsea pipe or cable connecting structures such as wellheads and subsea distribution units. Can be used to carry chemicals, hydraulic fluids and electricity supply.

V

W

Waste Electrical & Electronic Equipment (WEEE)	The Waste Electrical & Electronic Equipment (WEEE) Regulations 2006 implement the provisions of the WEEE Directive (2002/96/EC and 2003/108/EC). The aim of the WEEE Directive was to reduce the amount of WEEE disposed of in landfills and is achieved by essentially forcing producers of electrical and electronic equipment responsible for financing the collection, treatment and recovery of WEEE and requiring distributors of WEEE to enable consumers to return items and force through recycling activities in the market.
Water column	A theoretical column through a body of water from the surface to the sediments. This concept can be helpful when considering the different processes that occur at different depths.

X

Y

Z

Zooplankton	Broadly defined as heterotrophic (deriving energy from organic matter) planktonic organisms, although some protozoan zooplankton species can derive energy both from sunlight and by feeding on organic matter.

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1.0 NON-TECHNICAL SUMMARY

This non-technical summary outlines the findings of the environmental impact assessment (EIA) conducted by CNR International (UK) Limited (CNRI) as part of the planning and consents process for the future decommissioning of the Murchison Facilities. The purpose of the EIA is to understand and communicate the significant environmental impacts associated with the project options to inform the decision-making process. The detailed assessment is presented within the Environmental Statement.

The Murchison Facilities are located in the UK Continental Shelf (UKCS) Block 211/19 of the northern North Sea, approximately 240 km northeast of the Shetland Islands and 2 km west of the UK/Norway median line (Figure 1).

The Murchison field was discovered in 1976, with oil first produced in 1980. Oil from the Murchison Field is exported to the Sullom Voe Terminal in Shetland via the Dunlin Alpha platform. Gas export from the Murchison Field ceased in 2000.

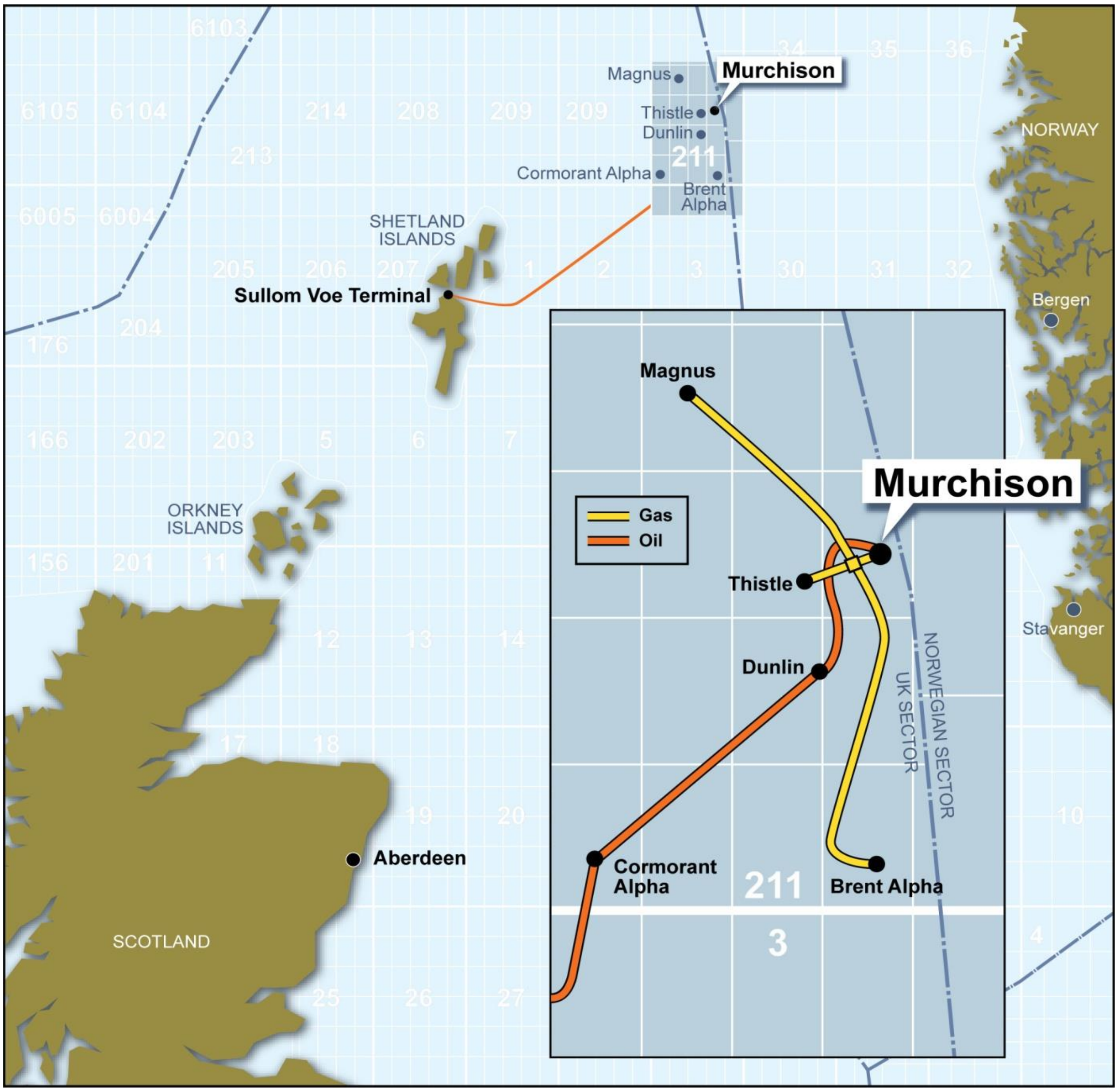


Figure 1: Location of the Murchison Facilities

1.1 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 (DECC, 2009a), 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 reuse 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.

OSPAR Decision 98/3 (the Decision) sets out the UK's international obligations on the decommissioning of offshore installations. The Decision prohibits the dumping and leaving wholly or partly in place of offshore installations. The Decision also allows 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 for large steel jackets weighing more than 10,000 tonnes and concrete gravity base structures. Exceptions are granted if a comparative assessment and consultation shows that there are significant reasons why an alternative disposal option is preferable to complete removal.

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

1.2 Scope of the Murchison Facilities Decommissioning Programme

The main scope of the programme includes the decommissioning of the Murchison Platform topsides and jacket, the drill cuttings pile at the Murchison Platform, the oil export pipeline from the Murchison Platform to Dunlin Alpha (PL115), the Dunlin riser and topside facilities for

Murchison production, three associated subsea wells (Wells 211/19-2, 211/19-3 and 211/19-4) and three tie-back pipeline bundles (PL123, PL124 and PL125) to the Murchison Platform.

The main elements of the Murchison Facilities decommissioning project are:

- the engineering-down and cleaning of the Murchison topside facilities;
- the removal and subsequent recovery to shore of the Murchison Platform topsides and jacket down to the footings, which will be left *in situ*;
- the decommissioning of subsea pipelines and umbilicals;
- the decommissioning of the Dunlin riser;
- the cleaning and decommissioning of those parts of the Dunlin topsides facilities that relate to Murchison production; and
- the removal of oil field debris in the 500 m zone and 100 m each side of the pipelines.

The platform and subsea wells will be plugged and abandoned in accordance with a well abandonment programme as Murchison nears its end of field life.

1.3 Decommissioning Studies

CNRI commissioned a number of studies to support the Murchison Field decommissioning planning process and option evaluation, in order to determine the recommended decommissioning option and optimal engineering solution. The conclusions from these studies have been included within the Environmental Statement. These studies include:

- Inventories of the assets, materials and hazardous materials on the Murchison Platform.
- Quantitative Risk Assessment and high level Hazard Identification Study (HAZID) of Decommissioning and Removal Options.
- A series of engineering studies and reports on the options for decommissioning the topsides, jacket and pipelines, including identification of potential onshore decommissioning yards.
- A comparative assessment for the decommissioning of the Murchison jacket, pipeline and drill cuttings pile.
- Pre-decommissioning environmental survey.
- Commercial Fisheries Socioeconomic impact study.
- Environmental assessments of underwater noise and energy and emissions from the decommissioning options, and modelling and impact assessment of the options for the management of the Murchison drill cuttings pile.

1.4 Recommended Decommissioning Options

CNRI conducted a formal comparative assessment of the options for decommissioning the Murchison jacket, the PL115 oil export pipeline and the drill cuttings pile in order to determine the recommended options, as required under the Petroleum Act 1998.

Table 1 provides an overview of the recommended decommissioning option for each of the Murchison Facilities, including those that were subject to the formal comparative assessment.

For both the Murchison Platform topsides and jacket more than one decommissioning method is being considered for the recommended decommissioning option. The specific method for the decommissioning of these facilities will be determined during the contracting phase of the project; for this reason, the impacts associated with all decommissioning methods for the recommended option are assessed in this EIA.

Table 1: Overview of recommended decommissioning options

Facility	Recommended Decommissioning Option	Possible Decommissioning Methods
Wells	Plug and abandonment and conductor recovery	In accordance with the Oil and Gas UK Guidelines for the Suspension and Abandonment of Wells (2012)
Topsides	Full removal	Reverse installation
		Piece-small removal of topsides
Jacket	Partial removal	Cut and lift sections using a heavy lift crane and barge
		Flotation in one piece following cutting at the top of the footings
Pipeline PL115	Burial	Remove spools and bury exposed sections by rock-placement
Pipeline bundles	Full removal	Cut and lift
Subsea wellheads	Full removal	Cut and lift
Cuttings pile	Leave *in situ*	Natural degradation

1.5 Environmental Setting and Sensitivities

The Murchison Facilities are located in a water depth of approximately 156 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 2 provides a summary of the key physical, chemical, biological and socioeconomic components of the environment in the Murchison Facilities area that may be subjected to environmental impacts.

Table 2: Summary of environmental sensitivities in the vicinity of the Murchison Facilities

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 Murchison Facilities area. Although *Lophelia pertusa* has colonised the Murchison Platform, it would not have occurred without the presence of the platform and therefore does not constitute an Annex I habitat (Fugro ERT, 2013).

Habitats Directive: Annex II Species

Of the Annex II species, only the harbour porpoise has been sighted in the Murchison Facilities area, with very high abundance in February and July, and low numbers throughout the summer months (May, June, August and September) (DECC, 2009b; SMRU, 2001).

Benthic Fauna

Benthic communities in the Murchison Facilities 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 (Fugro ERT, 2013).

Plankton

The plankton in the Murchison Facilities area is typical of the northern North Sea. Peak productivity occurs in spring and summer.

Finfish and Shellfish

The Murchison Facilities are located in spawning grounds for cod (January to April), whiting (February to June), haddock (February to May), Norway pout (January to April) and saithe (January to April); and in nursery grounds for herring, ling, mackerel, spur dog, haddock, Norway pout and blue whiting (throughout the year) (Coull *et al*., 1998; Ellis *et al*., 2010).

Marine Mammals

Marine mammals sighted in and around the Murchison Facilities area include minke whales, long-finned pilot whales, killer whales, white-beaked dolphins, white-sided dolphins, harbour porpoises and sperm whales. Peak sightings generally occur from May to September (Reid *et al*., 2003; UKDMAP, 1998).

Seabirds

Seabird vulnerability to oil pollution in the Murchison Facilities area is “high” in March, July, October and November and “moderate” to “low” for the rest of the year. The overall vulnerability in the Murchison Facilities area is “low” (JNCC, 1999).

Fisheries

The Murchison Facilities area is of “low” to “very low” relative value. Fishing effort is “low” to “very low” and dominated by demersal gear types. However, pelagic species historically dominate the landings in the vicinity of the Murchison Facilities, targeting mostly mackerel and herring (Marine Scotland, 2011a, 2011b).

Shipping

Shipping traffic in a 10 nautical miles (n miles) area of the Murchison Facilities ranged from low to high in density (Anatec, 2012).

Key

Very high sensitivity
High sensitivity
Moderate sensitivity
Low sensitivity
Not surveyed/No data available

1.6 Key Environmental Concerns

An Environmental Impacts Identification workshop was undertaken to identify the range of high level environmental impacts which might occur as a result of the proposed Murchison Facilities decommissioning operations. The workshop considered the planned and unplanned/accidental events that might occur during the lifetime of the proposed decommissioning operations. Following the identification of the interactions between the proposed decommissioning activities and the local environment, the assessment of all potentially significant environmental impacts and the stakeholder consultation, the following key environmental impacts were identified as requiring further assessment:

i) Energy use and atmospheric emissions

The main sources of atmospheric emissions from offshore decommissioning operations are the combustion of fuel for power generation on vessels. Throughout the proposed Murchison Facilities decommissioning operations there will be a variety of vessels present. The option to decommission the topsides by piece-small deconstruction is expected to require the largest energy use and largest atmospheric emissions. The decommissioning option to partially remove the jacket by flotation is expected to require the most energy.

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 project area as the impact is expected to be limited to the immediate vicinity of the operations. Emissions from the decommissioning activities will contribute to greenhouse gas emissions and will be kept to a practicable minimum. The proposed decommissioning operations will result in a reduction in CO_2 emissions when compared to the total CO_2 emissions generated by Murchison during normal operations in 2011. For this reason, there is unlikely to be a significant transboundary or cumulative impact on air quality.

ii) Underwater noise

Man-made underwater noise has the potential to impact on marine mammals. Several activities associated with the proposed decommissioning operations will generate underwater noise.

The main marine mammal species that occur in the Murchison Facilities area are minke whale, long-finned pilot whale, killer whale, white-beaked dolphin, white-sided dolphin and harbour porpoise, with most sightings occurring in the summer months. Due to the offshore locality of the Murchison Facilities (150 km from the nearest coastline), it is unlikely that significant numbers of grey or harbour seals will occur in the vicinity of the facilities.

Underwater cutting operations are expected to be the highest source of sound associated with the decommissioning activities, which therefore has the potential to interfere with marine mammals. However, the proposed cutting operations will be short in duration, lasting a few hours each over a period of days to weeks.

iii) Seabed disturbance

Decommissioning operations at the Murchison Facilities will result in work being undertaken at or near the seabed. Therefore, there is the potential for localised seabed disturbance. The cutting and lifting of the pipeline bundle PL125 may create some disturbance of the drill cuttings pile. This disturbance will be relatively small and occur from the manoeuvring of the remotely operated vehicle and cutting equipment. These activities will be controlled to ensure accurate cutting and lifting thereby minimising the risk of pile disturbance.

In addition, leaving the drill cuttings pile *in situ* may lead to some long-term impacts arising from the physical presence of the cuttings pile and from the eventual collapse of the Murchison jacket footings. Such an event may result in a relatively small disturbance of the pile.

Rock-placement activities associated with the pipeline burial will modify the seabed and result in physical disturbance causing suspension of material. This impact will be minimised by controlled rock-placement over a minimal footprint. The profile of the rock-placement will allow fishing nets to trawl over the rock unobstructed.

iv) Socioeconomic impacts

Potential socioeconomic impacts can arise as a result of the proposed decommissioning activities. These are:

- interference to fishing activities;
- damage to, or loss of, gear; and
- onshore impacts.

There will be minor impact to fishing activities in the Murchison Facilities area as a result of the proposed decommissioning operations. This impact will be managed by minimising the number of vessels travelling to, or standing by, Murchison. CNRI will minimise potential damage or loss of demersal fishing gear as a result of the partial removal of the jacket by notifying the appropriate organisations or authorities of any subsea structures left in place after decommissioning.

v) Waste

Decommissioning the Murchison Facilities will generate quantities of controlled waste. The amount of controlled waste generated at any one time during the decommissioning operations will depend on the processes used for dismantling and the subsequent treatment and disposal methods utilised. The objective is to recycle as much of the waste material as possible.

CNRI will develop a Murchison Facilities Waste Management Plan to translate a Waste Management Strategy into individual project plans with defined actions, roles and responsibilities. The scope of the Facilities Waste Management Plan will cover the decommissioning programme for the selected removal options and disposal routes.

vi) Accidental events

Accidental events, such as the accidental release of hydrocarbons and chemicals, can result in a complex and dynamic pattern of pollution distribution and impact on the marine environment. Although the likelihood of such a spill is remote, there is a potential risk to organisms in the immediate marine and coastal environment, and a socioeconomic impact if a spill were to occur.

The residual risk of environmental impact from accidental oil spills will be reduced by preventive measures incorporated during design, operational control procedures and training. Any hydrocarbon discharge would be expected to disperse rapidly in the immediate environment. The majority of chemical spills will likely pose little threat to the environment owing to a combination of rapid dispersion and dilution of the chemicals and the depth and distance from shore of the Murchison Facilities.

During the proposed operations, there is the potential for the loss of objects dropped overboard which may present a hazard to shipping, fishing activities and may also impact the seabed community within the drop zone. Where practicable CNRI will endeavour to minimise the number of dropped objects and will secure items to prevent loss during the proposed decommissioning operations. The recovery of debris wherever practicable will be undertaken to minimise the impact on the environment and to minimise the risk to other users of the sea.

1.7 Environmental Management

A Register of Commitments has been developed to address each aspect of the Murchison Facilities Decommissioning and to provide a summary of key management and mitigation measures identified during the EIA process. This register will form part of the Decommissioning Environmental Management Plan and will be integrated into the relevant project phases.

1.8 Conclusions

Overall, the Environmental Statement has evaluated the environmental risk reduction measures to be taken by CNRI and concludes that CNRI have, or intend to, put in place sufficient safeguards to mitigate environmental risk and to monitor the implementation of these safeguards.

Therefore, it is the conclusion of the Environmental Statement that the recommended options to decommission the Murchison Facilities can be completed without causing significant impact to the environment.

2.0 INTRODUCTION

This Environmental Statement (ES) presents the findings of the environmental impact assessment (EIA) undertaken by CNR International (UK) Limited (CNRI) for the decommissioning of the Murchison Facilities including the Murchison Platform and associated drill cuttings pile, pipelines and subsea infrastructure, all located within the Murchison Field.

2.1 Location of the Murchison Facilities

The Murchison Facilities are located in UK Continental Shelf (UKCS) Block 211/19 of the northern North Sea, approximately 240 km northeast of the Shetland Islands and 2 km west of the UK/Norway median line (Figure 2.1). Water depth at the Murchison Facilities is approximately 156 m.

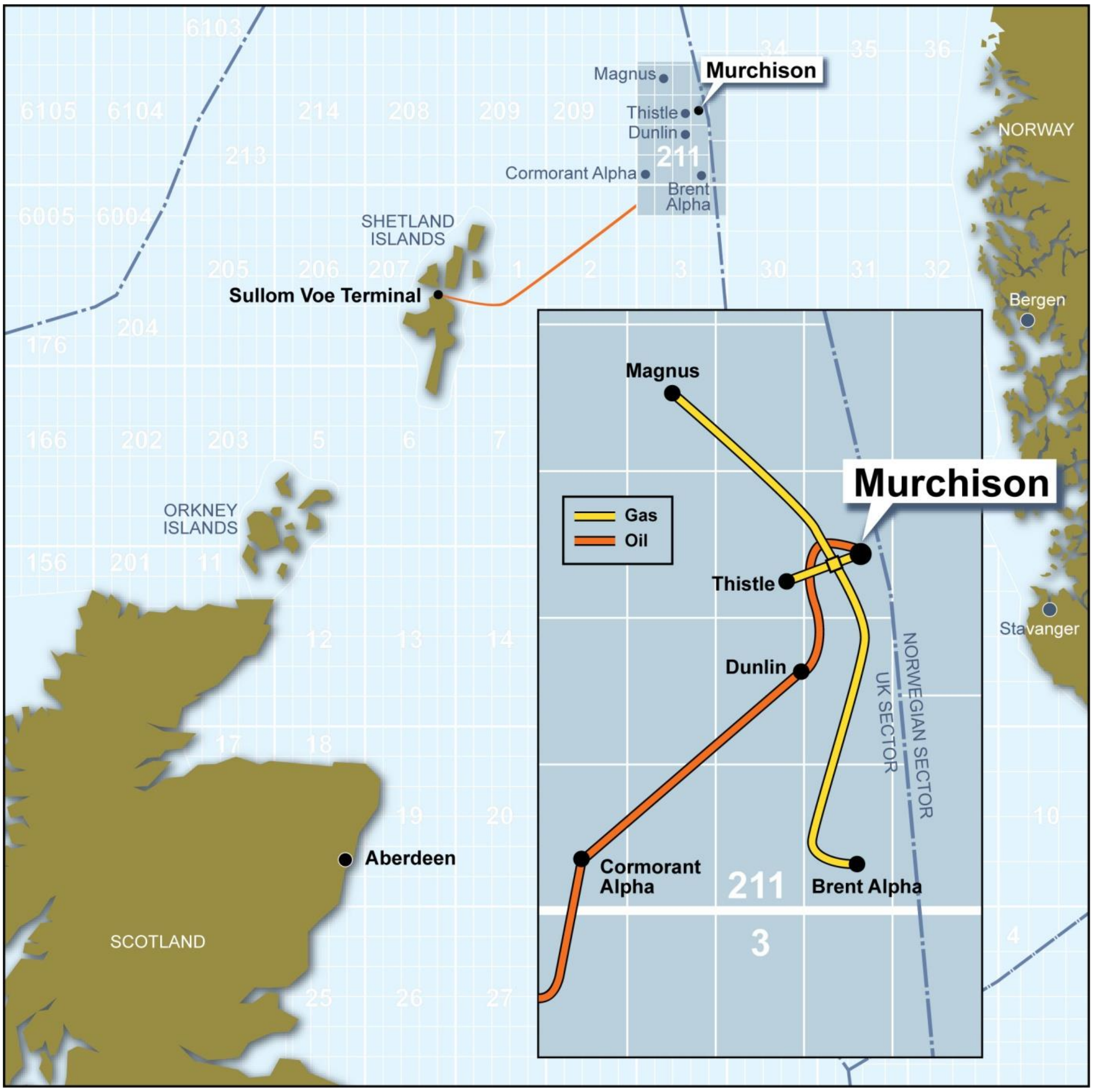


Figure 2.1: Location of the Murchison Facilities

2.2 Project Background and Purpose

The Murchison Field, where the Murchison Facilities are located, was discovered in 1976 by Conoco (UK) Ltd., with first oil achieved in 1980. CNRI and co-venturer Wintershall Norge ASA (22.2% ownership) acquired the Murchison Field in 2002. In 2009, production levels became economically marginal at approximately 4.7% of peak annual production, and the decision was taken to commence planning for field decommissioning.

2.3 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 Murchison Facilities Decommissioning Programme (Section 2.4).

The purpose of the EIA process is to understand and communicate the significant environmental impacts associated with the project options to inform the decision making process (Section 3). The ES presents the findings of the EIA process and has been prepared as part of the planning and consents process for the future decommissioning of the Murchison Facilities.

2.4 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. 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 Guidance Notes) 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.
- Potential impacts on amenities, the activities of communities 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) sets out the UK's international obligations on the decommissioning of offshore installations. The Decision prohibits the dumping and leaving wholly or partly in place of offshore installations. The topsides of all installations must be returned to shore and all installations with a jacket weight of less than 10,000 tonnes must be completely removed. However, the Decision recognises that there may be difficulty in removing large steel jackets weighing more than 10,000 tonnes and concrete gravity base structures; therefore, it 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. Exceptions will only be granted if a comparative assessment and consultation shows that there are significant reasons why an alternative disposal option is preferable to complete removal.

The provisions of the Decision do not apply to pipelines; however, as mentioned above, the Petroleum Act 1998 provides the framework for the orderly decommissioning of offshore pipelines. The DECC Guidance Notes state that 'because of the widely different circumstances of each case, it is not possible to predict with any certainty what may be approved in respect of any class of pipeline'. Therefore all feasible pipeline decommissioning options should be considered and a comparative assessment made.

A summary of the environmental legislation applicable to this project is provided within Appendix A.

2.5 Report Structure

The ES Structure is detailed within Table 2.1.

Table 2.1: Structure of the Environmental Statement

Section		Contents
1	Non-Technical Summary	A summary of the ES
2	Introduction	An introduction to the project and the scope of the ES
3	Methodology	The methodological approaches used in the EIA process and a summary of the supporting reports and studies undertaken
4	Project Description	A description of the decommissioning options and the recommended decommissioning option determined by a formal Comparative Assessment (CA) process
5	Environmental Description	A description of the environment and sensitive receptors in the vicinity of the project area
6	Stakeholder Views	Details of the consultation process and outcomes
7	Risk Assessment	A detailed description of the risk assessment approach and findings
8	Energy Use and Atmospheric Emissions	A quantification of energy use, identification of emission sources and potential impacts of emissions
9	Underwater Noise	Identification of sound sources and potential impacts of noise
10	Seabed Disturbance	Identification of sources of seabed disturbance and potential impacts
11	Socioeconomic Impacts	Description of the potential socioeconomic impacts of the project
12	Waste	Details the waste likely to be generated and the management processes to be implemented during decommissioning activities
13	Accidental Events	Worst case scenarios and measures to prevent spills arising from accidental events, and proposed contingency measures to ensure an effective response in the event of a spill
14	Environmental Management	A description of CNRI’s environmental management procedures and how these will apply to the decommissioning of the Murchison Facilities. The section also includes a Register of Commitments made within the ES
15	Conclusions	Key findings and conclusions
16	References	Sources of information used to inform the assessment
	Appendix A: Legislation	A summary of relevant environmental legislation
	Appendix B: Environmental Impacts Identification	A summary of the Environmental Impacts Identification workshop results
	Appendix C: Energy Use and Atmospheric Emissions Supporting Information	Additional information to support the Energy Use and Atmospheric Emissions Assessment

3.0 METHODOLOGY

The EIA systematically identifies significant environmental impacts and risks (potential impacts) associated with the project and assesses the requirement for impact/risk mitigation measures. The objective of the EIA process is to incorporate environmental considerations into project planning and design to ensure that best environmental practice is achieved.

The ES was prepared in accordance with the Offshore Petroleum Production and Pipelines (Assessment of Environmental Effects) Regulations 1999 (as amended), with this section of the ES describing the methods used to:

- identify and evaluate the potential environmental (including social) impacts arising from the decommissioning of the Murchison Facilities;
- ensure an appropriate level of assessment is applied to the identified impacts, particularly those impacts identified as being significant; and
- identify actions needed, through design or management control, to avoid or mitigate the key anticipated impacts.

3.1 Environmental Impact Assessment Process

An overview of the EIA process to identify and assess the impacts associated with the Murchison Facilities decommissioning programme is provided within Table 3.1 and Figure 3.1.

Table 3.1: Key stages of the EIA process for decommissioning

EIA Stage	Description
Scoping	Scoping of the EIA allows the study to establish the key issues, data requirements and impacts to be addressed in the EIA and the framework or boundary of the study.
Consideration of alternatives	Demonstrates that other feasible approaches, including alternative uses, end points and decommissioning methods have been considered.
Description of project actions	Provides clarification of the purpose of the project and an understanding of its various characteristics – including stages of decommissioning, location and processes.
Description of environmental baseline	Establishes the current state of the environment on the basis of data from literature and field surveys and may involve discussions with the authorities and other stakeholders.
Identification of key impacts and prediction of significance	Seeks to identify the nature and magnitude of identified change in the environment as a result of project activities and assesses the relative significance of the predicted impacts.
Impact mitigation and monitoring	Outlines the measures that will be employed to avoid, reduce, remedy or compensate for any significant impacts. Mitigation measures will be developed into a project environmental management plan. Aspects of the project which may give rise to a significant impact and which cannot be mitigated to an acceptable level of impact may need to be redesigned. This stage will feed back into project decommissioning activities.
Presentation of the ES	Reporting of the EIA process, through the production of an ES, which clearly outlines the processes above. The ES provides a means to communicate the environmental considerations and environmental management plans associated with the project to the public and stakeholders.
Monitoring	Environmental monitoring will continue beyond the decommissioning phase at a periodicity agreed with DECC.

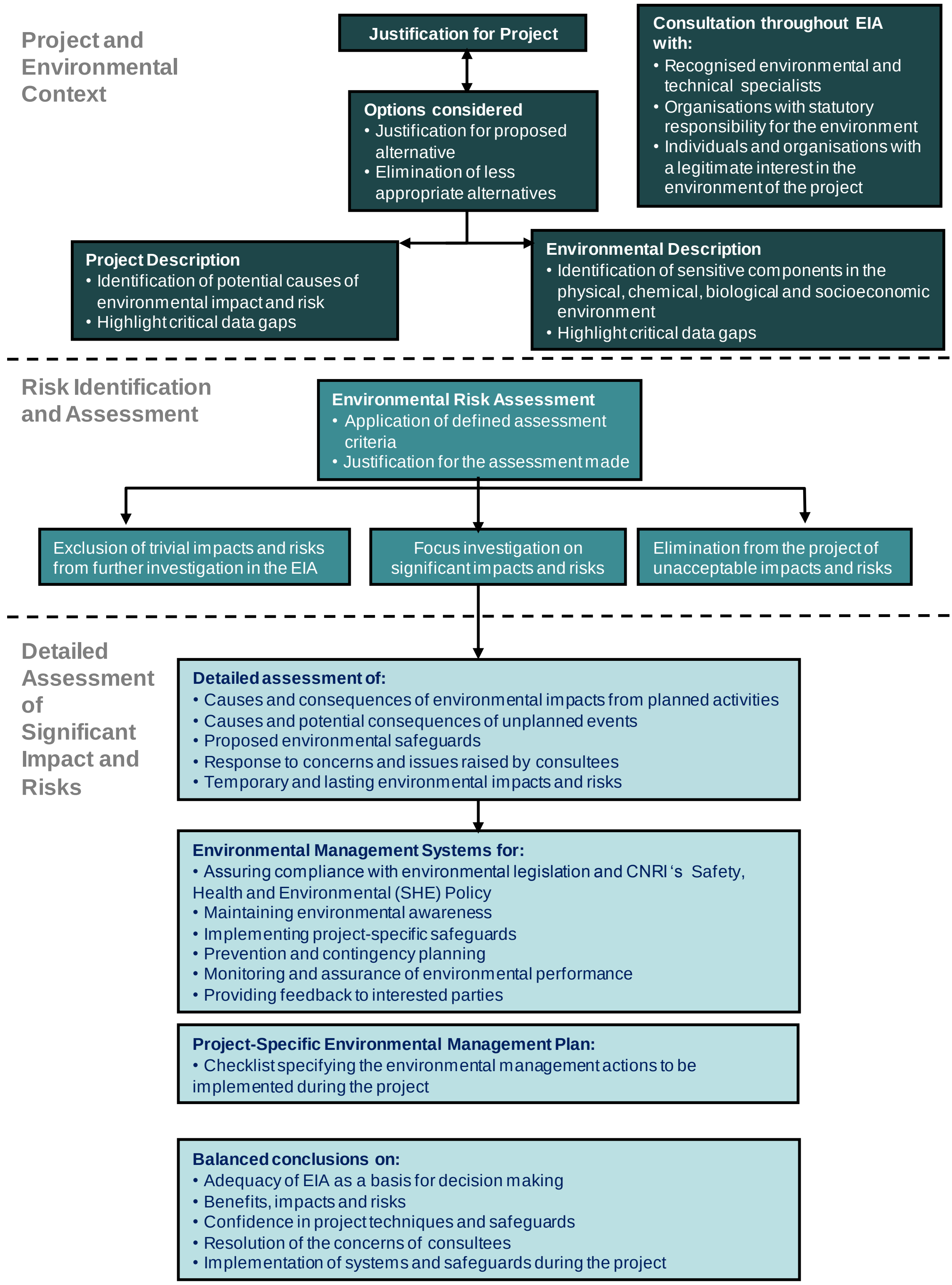


Figure 3.1: Principal stages in the EIA process

3.1.1 Scoping

Scoping is an integral part of the impact assessment process, the aim of which is to identify potential impacts to be assessed in greater detail within the ES. Scoping is a two-stage process comprising:

- an initial identification of potential effects; and
- a preliminary evaluation of significance based on available information.

The Murchison Facilities Environmental Impact Scoping Assessment (BMT Cordah, 2012a) identified the potential environmental receptors and other considerations which may be impacted by the proposed decommissioning operations (Figure 3.2).

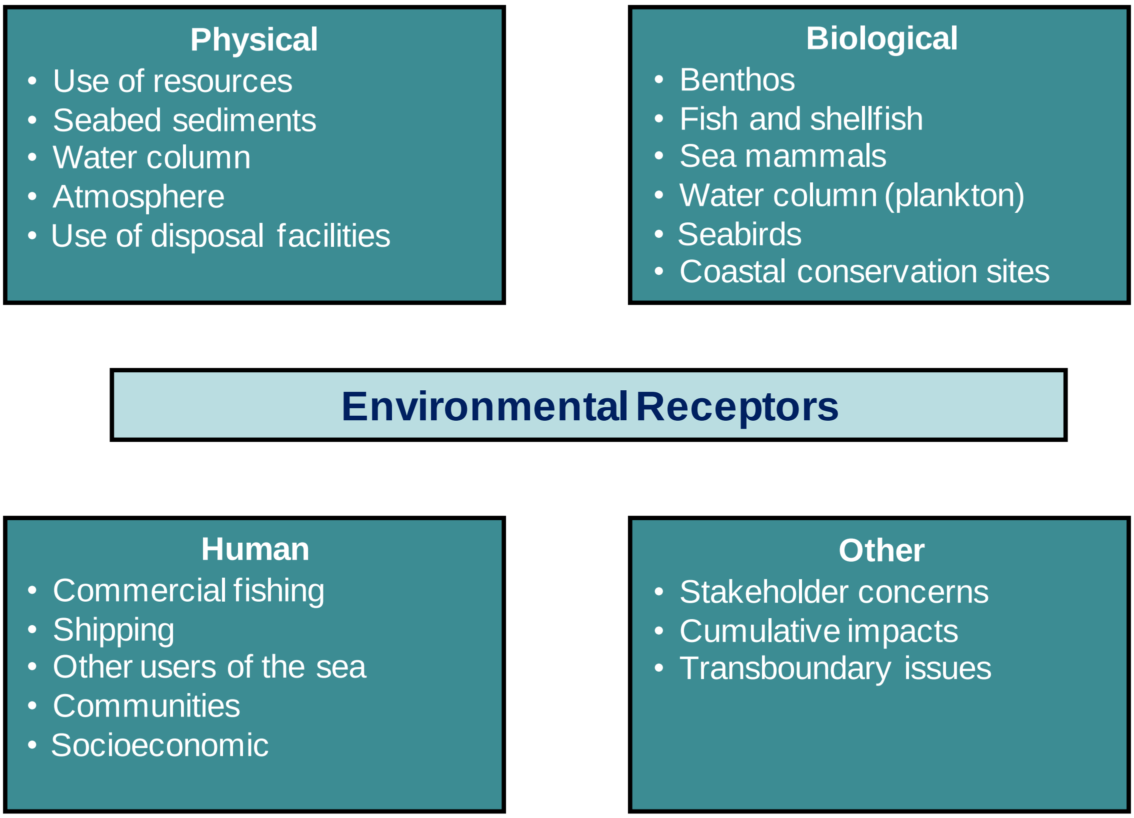


Figure 3.2: Environmental receptors

A summary of the issues identified during the scoping exercise for further assessment during the EIA includes:

- physical presence of vessels causing potential interference with other users of the sea;
- effects of seabed disturbance during decommissioning operations – vessel anchoring, trenching pipelines, rock-placement;
- effects of drill cuttings disturbance;
- effects of energy use and atmospheric emissions;
- effects of underwater noise generated during decommissioning activities;

- effects associated with near-shore and onshore dismantling of structures – noise, odour and dust;
- cleaning of marine growth from Murchison jacket;
- landfill disposal and associated impacts;
- safety risk to fishermen from derogated footings, pipelines, rock-placement and dropped objects;
- socioeconomic impact to fishermen from the derogated footings and pipelines; and
- non-routine events – spillage of hydrocarbons and other fluids.

The above issues were further validated and assessed through baseline assessments, an Environmental Impacts Identification workshop, modelling studies, stakeholder engagements and the detailed ES.

3.1.2 Environmental Impacts Identification Workshop

To inform the EIA a workshop was conducted on completion of the engineering studies and the environmental baseline survey, to ensure all activities potentially associated with the Murchison Facilities decommissioning options could be fully assessed.

The key objectives of the workshop were to validate impacts identified through a scoping matrix, identify any additional potential environmental issues likely to arise from the proposed project and to agree the appropriate control and practicable measures required to manage the identified impacts (Section 7).

3.1.3 Cumulative and Transboundary Impacts

The EIA process also includes the identification of any potential cumulative or transboundary impacts that could be caused by the proposed decommissioning programme. Cumulative impacts occur as a result of a number of activities (e.g. discharges or emissions) combining or overlapping and potentially creating a new impact. Even where impacts do not overlap, it is important to consider the incremental effect of many small areas of impact on a particular environment or its use. Transboundary impacts are those which could have an impact on the environment and resources beyond the boundary of UK waters. The Convention on Environmental Impact Assessment in a Transboundary Context (Espoo, 1991) addresses the need to enhance international co-operation in assessing transboundary environmental impacts.

3.2 Comparative Assessment

The Murchison jacket weighs approximately 27,584 tonnes and as such is a candidate for derogation from the rule of total removal under the Decision. Pipeline PL115 is a 19 km long 16” oil export pipeline with partial rock-placement and is subject to a Comparative Assessment (CA) to identify the optimal decommissioning solution under the Petroleum Act 1998. In order to determine the recommended decommissioning option CNRI conducted a formal CA of possible decommissioning options to establish whether there was a difference between options and if so which option performed the best. Each decommissioning option was assessed against the five main DECC criteria – safety, environment (informed by the EIA process), technical, societal and economic. All decommissioning options and the subsequent recommended option are described within Section 4. The EIA process assessed the impacts of all decommissioning options with assessment sections 9 to 14 of the ES considering only the recommended option as identified within the CA process.

3.3 Supporting Studies

CNRI commissioned a number of studies to support the initial decommissioning planning process and option evaluation, in order to determine the recommended decommissioning option and optimal engineering solution (Table 3.2)

Table 3.2: List of decommissioning studies

Decommissioning Aspect	Study Title
Inventory	Asset Inventory Study Report
	Materials Inventory and Residual Materials Study Report
Engineering	Platform Removal Technology Study
	Platform Shut-down Procedure
	Engineering and Clean Down
Topsides	Topside Offshore Deconstruction
	Topside Reverse Installation Removal
	Topsides Single Lift Removal
	Module Separation Study
	Topside Weight Review
	Topsides CA
	Topsides Process Study
	Idle Phase Requirements
	Utility and Life Support Systems
	Topside 3d Laser Survey
Jacket	Jacket Buoyancy Tank Assembly Removal Option
	Jacket Removal in Sections
	Jacket Single Lift Removal
	Jacket Weight Report
	Jacket CA
	Jacket Long-Term Monitoring Requirements
	Murchison Preliminary Footings Life Assessment
	Murchison Jacket Structure Intelligent USFOS Modelling
	Subsea Cutting Techniques Study
	Evaluation of Removal Options for Jacket

Table 3.2 (continued): List of decommissioning studies

Decommissioning Aspect	Study Title
Pipeline	Murchison Subsea and Pipeline Assets - Decommissioning Report
Management of drill cuttings pile	Murchison Drill Cuttings Pile Modelling the Effects of Human Disturbance of the Cuttings Pile Report
	Murchison Drill Cuttings Pile Long-Term Cuttings Pile Characteristics Report
	Modelling of Collapse of Jacket Footings into Cuttings Pile
	Environmental Assessment of Options for the Management of the Murchison Drill Cuttings Pile
Environmental studies	Murchison Pre-Decommissioning Environmental Baseline Survey
	Murchison EIA Scoping Report
	Commercial Fisheries - Socioeconomic Impact Study
	Murchison Environmental Impacts Identification workshop
	Energy and Emissions Report for the Decommissioning of Murchison
	Underwater Noise Impact Assessment for the Murchison Field Decommissioning

4.0 PROJECT DESCRIPTION

This section presents the Project Description of the ES for the decommissioning of the Murchison Facilities.

4.1 Background Information

The Murchison Field, where the Murchison Facilities are located, were discovered in 1976 by Conoco (UK) Ltd. who subsequently developed the field, installing a drilling, accommodation and production platform supported by an 8-legged steel jacket comprising 33 platform well slots. First oil was achieved in 1980 and 98 wells including sidetracks have been drilled at Murchison over its field life. Peak oil and gas production was achieved in 1983, at 5,332,788 m^3 oil/year and 540,029 kSm^3 gas/year (DECC, 1975). Annual production subsequently declined and Conoco sold its interest to Oryx UK Energy Company in January 1995, at an annual production of 645,003 m^3 oil and 69,745 kSm^3 gas (DECC, 1975). Oryx operated the Murchison Field until 1999 at which time they relinquished operatorship to Kerr-McGee. CNRI and their co-venturer Wintershall Norge ASA (22.2% ownership) acquired the Murchison Field from Kerr-McGee in 2002, when the field was yielding an annual production of 379,291 m^3 oil and 30,519 kSm^3 gas (DECC, 1975). Gas export from the Murchison Field ceased in September 2000 as recovery rates fell below the level required for platform fuel gas and Murchison subsequently commenced importing gas to meet platform fuel requirements. In 2009, production levels had become economically marginal at approximately 4.7% of peak annual production and the decision was taken to commence planning for field decommissioning.

4.1.1 Layout, Infrastructure, Adjacent Facilities and Tie-ins

The Murchison Facilities are located in UKCS Block 211/19 of the northern North Sea, approximately 240 km northeast of the Shetland Islands and 2 km west of the UK/Norway median line (Figure 4.1). Water depth at the facilities is approximately 156 m. The Murchison oil reservoir is located approximately 3,018 m below the seabed in the Jurassic Brent sands and extends from Block 211/19 in the UKCS into Block 33/9 in the Norwegian Continental Shelf. The Murchison Platform is located at:

- Latitude: 61° 23’ 49.0” N
- Longitude: 01° 44’ 25.5” E

The Murchison Platform is linked to the Dunlin Alpha (A) platform (operated by Fairfield Energy Limited) by a 19 km, 16” oil export line (Figure 4.2). Produced oil from the Murchison Platform is exported to the Sullom Voe Terminal in the Shetland Islands via the Dunlin A platform where Murchison oil combines with oil from Thistle and Dunlin A and passes into a 24” pipeline to Cormorant Alpha (A). From Cormorant A the oil is transported to Sullom Voe via the 36” Brent System Main Oil Line. Murchison is also linked to the Northern Leg Gas Pipeline (NLGP) via a 2.6 km, 6” gas import/export spur pipeline which connects to the NLGP Subsea Isolation Valve (SSIV) and crossover Tee and a control umbilical from Murchison to the NLGP SSIV.

The gas export pipeline (PL165) and the SSIV control umbilical are owned by the NLGP partners (of which CNRI is a partner) hence are not within the CNRI scope of work for Murchison decommissioning. However, CNRI will consider the potential environmental impacts of cutting the gas export pipeline and umbilical adjacent to the Murchison Platform.

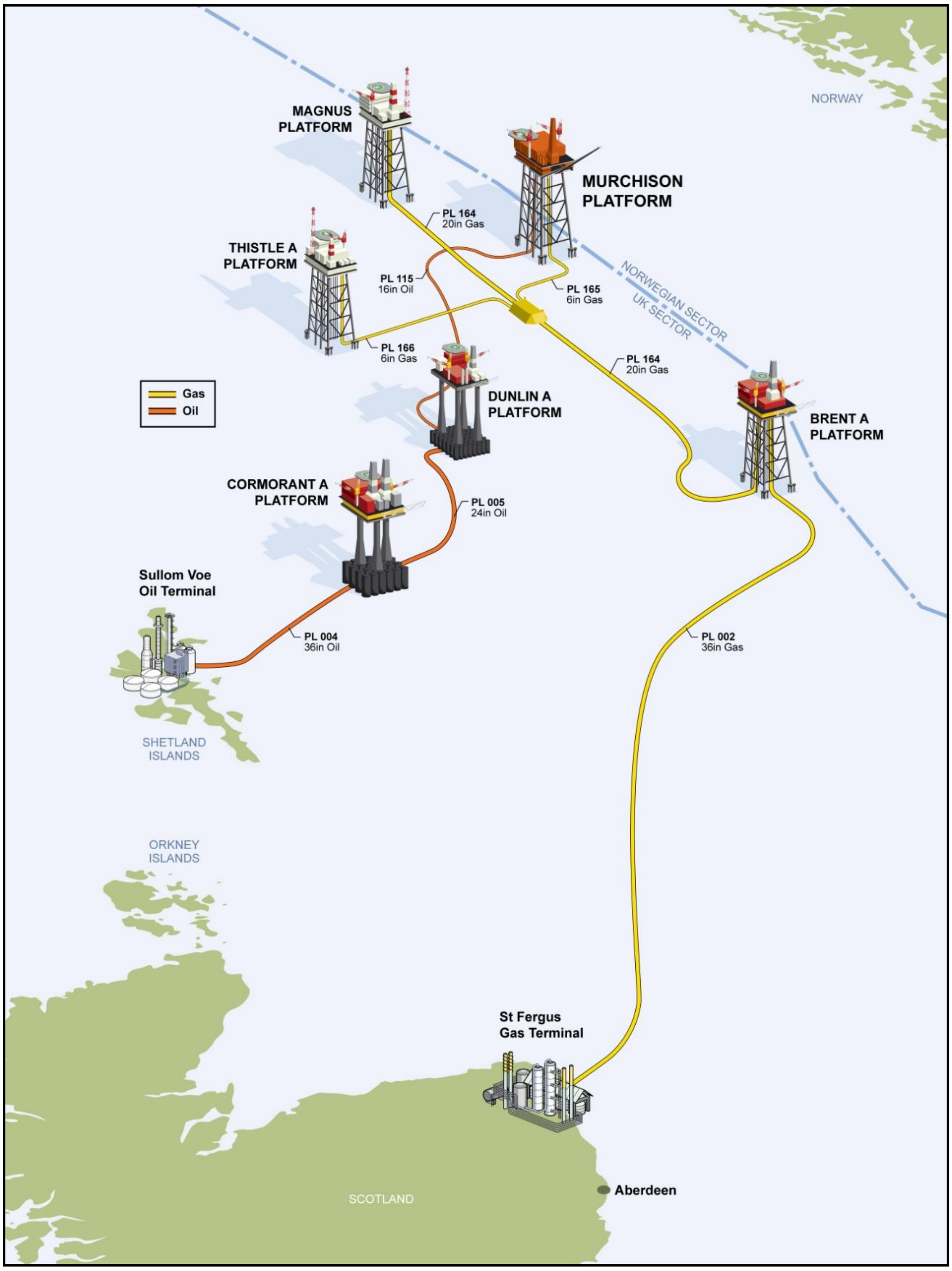


Figure 4.1: Location of the Murchison Platform

There are also three tie-in spools which are positioned at each end of the oil export pipeline and at the Murchison end of the gas export pipeline. Murchison has three subsea wells; one remains live but not in production (211/19-2) and two are abandoned (211/19-3 and 211/19-4). There are guide bases and wellhead protection structures in place on 211/19-2 and laid to the side of 211/19-4 (Section 4.2; Table 4.2). The subsea wells are connected to the Murchison Platform by individual pipeline bundles, all of which are out of service.

4.1.2 Other Seabed Infrastructure

There are third party pipelines in the vicinity of the Murchison Platform which cross the Murchison 16” oil export pipeline and therefore have a bearing on the decommissioning programme for the Murchison Facilities. These pipelines are summarised in Table 4.1.

Table 4.1: Summary of third party pipelines crossing Murchison Facilities

Operator	Description	Pipeline Number	Crossing Murchison Facility
Shell	Brent 'C' SSIV to Penguins Control Umbilical	PLU1903	PL115
Shell	Brent 'C' SSIV to Penguins - 16"/22" pipe-in-pipe	PL1902	PL115
Shell	Brent 'C' to Penguins DC2 - 4" gas lift Pipeline	PL2228	PL115
BP	NLGP SSIV to Thistle – 6” gas pipeline (NLGP)	PL166	PL115
BP	Magnus to Brent 'A' - 20" gas pipeline (NLGP)	PL164	PL115
Fairfield	Thistle to Dunlin – 4” gas import pipeline	PL2852	PL115

Source: Atkins (2011a)

4.2 Description of Facilities to be Decommissioned

The facilities which are included in the Murchison Facilities Decommissioning Programme and the Pipelines Decommissioning Programme, both of which will be contained in the Murchison Field Decommissioning Document, are shown in Figure 4.2 and detailed in Table 4.2.

Table 4.2: Overview of facilities to be decommissioned

Murchison Facility	Components of the Facility to be Decommissioned
Topsides	Modules and associated topside equipment Module Support Frame (MSF)
Jacket and footings	188 m high steel jacket structure 33 conductors 32 structural piles
Pipelines	19.1 km 16” oil export pipeline and associated tie-in spools (PL115) 0.78 km pipeline bundle (PL123) 1.99 km pipeline bundle (PL124) 1.23 km pipeline bundle (PL125)
Subsea wells and protection structures	Well 211/19-2 – live well still to be abandoned – wellhead, guide base and protection structure in place Well 211/19-3 – well abandoned - survey indicated no remaining infrastructure (Atkins, 2011a) Well 211/19-4 – well abandoned - guide base and protection structure laid to side
Other seabed materials	Drill cuttings pile at the base of the jacket Debris at the base of the jacket and in the surrounding 500 m zone and along the routes of the pipelines and umbilical Other materials (e.g. pipeline protection mattresses, rock-placement, grout mats, pipeline crossings and frond mattresses)

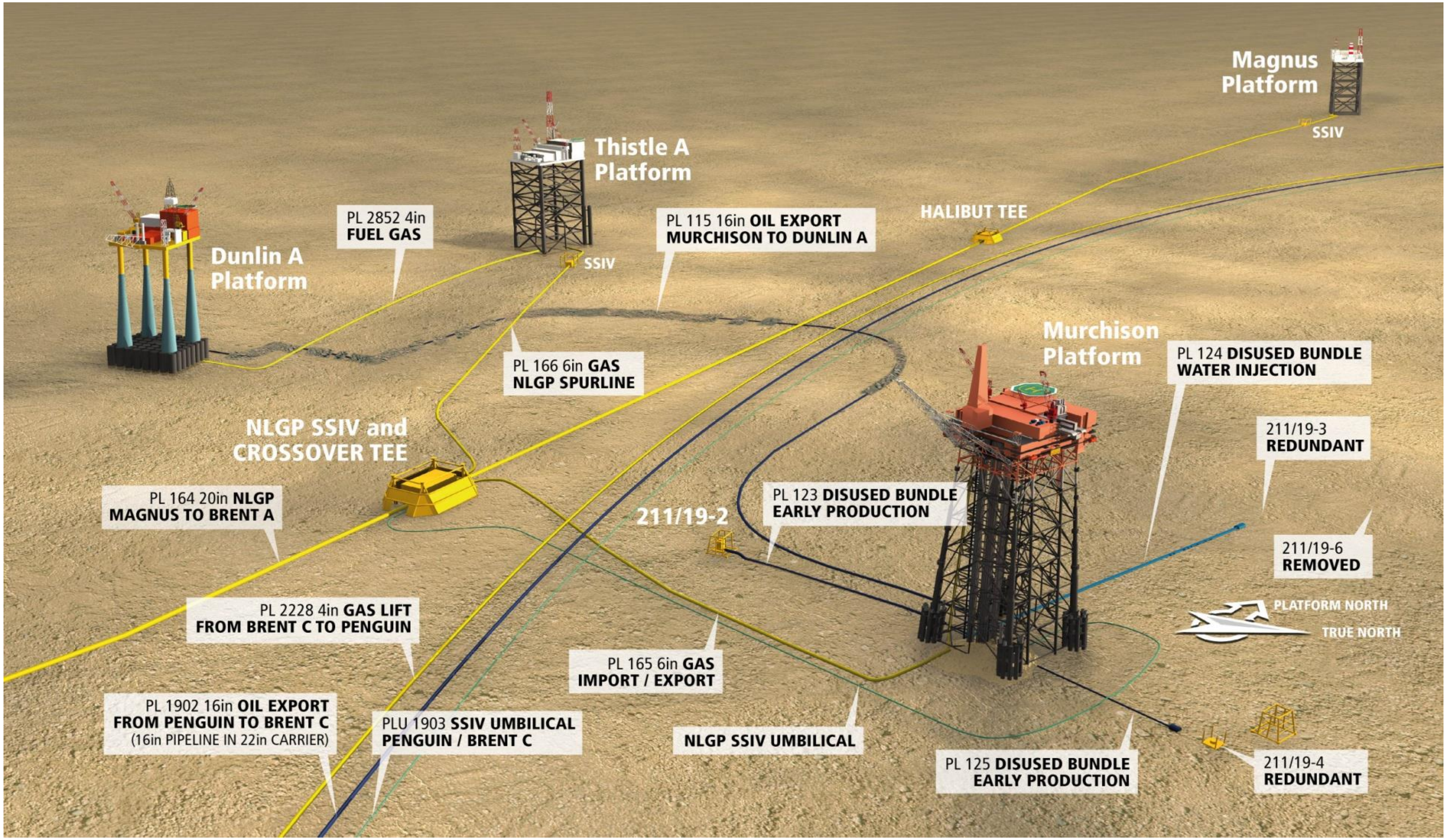
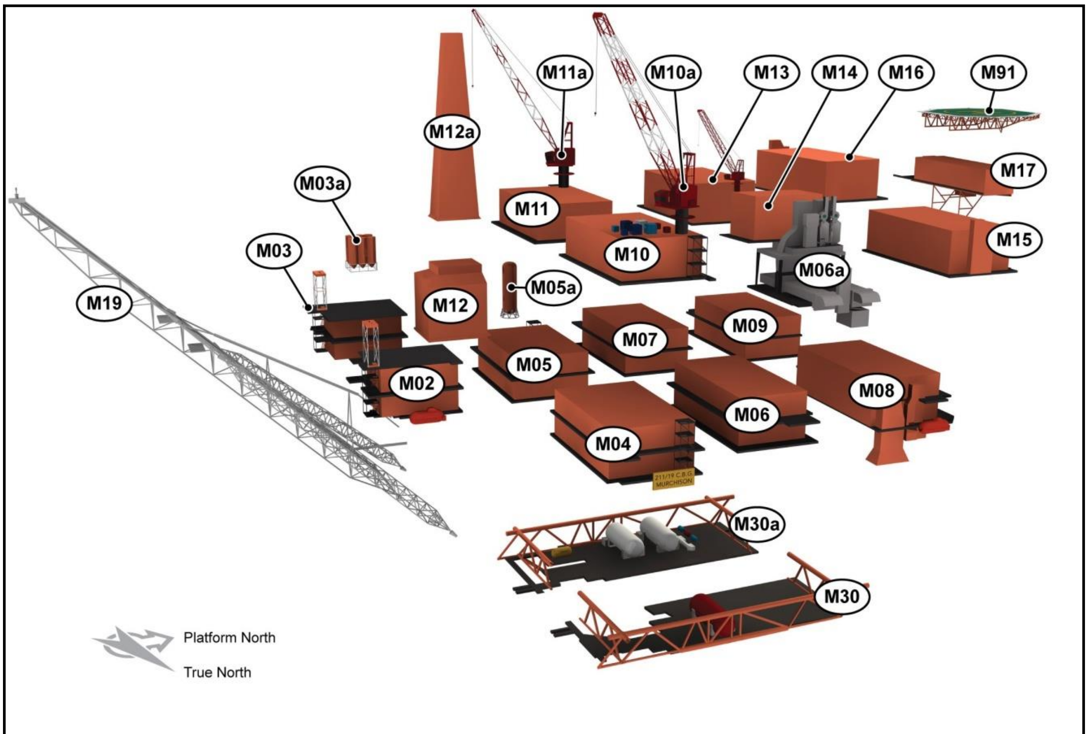


Figure 4.2: Schematic diagram of the Murchison Facilities layout

4.2.1 Topsides

The topsides of the Murchison Platform comprise 20 main modules arranged over two levels which provide facilities and equipment for drilling, production, processing, power generation, export and accommodation (CNRI, 2011a). In addition to the main modules, there are: MSFs below the lower module deck; walkways below the MSFs; a helicopter landing platform; a single drilling derrick; a 109 m flare boom; and east and west pedestal cranes located on the roof level.

Figure 4.3 shows the general arrangement of the modules and other facilities on the Murchison topsides.



MODULE	DESCRIPTION
M02	Wellbay East (WBE)
M03	Wellbay West (WBW)
M03a	Bulk Storage Tanks (BST)
M04	Separation Module (SEP)
M05	Metering Module (MET)
M05a	Deareator Column
M06	Gas Compression Module (GCM)
M06a	Rolls Royce Generators and Exhausts
M07	Gas Sales Module (GSM)
M08	Utilities Module East (UME)
M09	Utilities Module West (UMW)
M10	Drilling Power & Fabrication Workshop (DPF)
M10a	East Platform Crane (ECR)

MODULE	DESCRIPTION
M11	Mud Module (MUD)
M11a	West Platform Crane (WCR)
M12	Drilling Substructure (DRS)
M12a	Drilling Derrick (DRK)
M13	MCR and Workshop (MCR)
M14	Power Generation Module (PWR)
M15	Accommodation East (LQE)
M16	Accommodation West (LQW)
M17	Accommodation New (LQN)
M19	Flare Boom (FLB)
M30	Module Support Frame East (MSFE)
M30a	Module Support Frame West (MSFW)
M91	Helideck (HEL)

Figure 4.3: Schematic diagram of the main modules and facilities on the Murchison topsides

Inventory of Materials Associated with Topside Decommissioning

Table 4.3 provides a summary of the quantities of materials associated with the Murchison topsides. The total weight of the Murchison topsides are approximately 24,584 tonnes (CNRI 2011a).

Table 4.3: Inventory of materials associated with topside decommissioning.

Material	Mass (tonnes)	Material	Mass (tonnes)
Steel	17,436.8	Rubber	108.1
Concrete	185.7	Wood	8.2
Aluminium	3.5	Polychlorinated biphenyls (PCBs)	0.3
Stainless steel	1,236.2	Residual oils	23.4
Copper	2,948.6	Paint	59.9
Lead	21.8	Passive fire protection	1,210.6
Zinc	6.3	Mercury	2×10^{-6}
Plastics	1,228.1	Other	0.5
Rockwool	106.1	Asbestos*	188 Locations
		TOTAL	**24,584**

*Weight is not known
Source: CNRI (2011a)

4.2.2 Jacket

The Murchison jacket is a welded, tubular steel, eight-legged structure (Figure 4.4). The four main legs are the corner legs, with diameters increasing from 2 m at the waterline to 6 m at the seabed. Two of the corner legs each contain a diesel storage tank which extends from +6.65 m to the -81 m elevation.

Each leg is secured to the seabed by a cluster of eight piles, each with a 2,134 mm diameter x 63 mm wall thickness. The piles are approximately 80 m long, of which approximately 50 m is driven into the seabed and the remaining 30 m extends above the seabed within the pile guides. There is a steel mudmat on the base of each leg to prevent the jacket from sinking into the seabed whilst the piles were being driven. The piles are fixed to the jacket by grout which cements them into the 25 m long pile sleeves attached to the legs. An impressed current system provides the primary cathodic protection for the jacket. This is augmented by a sacrificial anode system which provides approximately 25% of the required protection.

In total, the steel jacket weighs approximately 27,584 tonnes and is 188 m high from the seabed to the top of the MSF (CNRI, 2011b). In addition, the sections of piles extending above the seabed contribute 4,243 tonnes of steel, and the sacrificial anodes contribute 501 tonnes of zinc-aluminium alloy (CNRI, 2011b) (Table 4.4).

Figure 4.4: Schematic diagram of the Murchison jacket structure

Inventory of Materials Associated with Jacket Decommissioning

Table 4.4 provides a summary of the quantities of materials associated with the Murchison jacket.

Table 4.4: Inventory of materials for the Murchison jacket

Component	Weight (tonnes)
Structural steel jacket	14,439
Secondary steel jacket (caisons, risers etc.)	4,898
Steel from piles	4,243
Sacrificial anodes (zinc-aluminium alloy)	501
Grout	1,109
Densitometers (no. 72)	Negligible
Marine growth	2,394
TOTAL	27,584

Source: CNRI (2011b)

4.2.3 Pipelines

The Murchison Platform is serviced by three main pipelines; a 16” oil export pipeline to the Dunlin A platform (PL115), a 6” gas export/import spur pipeline to the NLGP (PL165) and a 94 mm control umbilical from the Murchison subsea control unit (SCU) to the NLGP SSIV. The 6” gas export/import pipeline and 94 mm control umbilical are owned by the NLGP partners hence are not within the scope of the Murchison Decommissioning Programme. In addition, there are three pipeline bundles (PL123, PL124 and PL125) which connect the three subsea wells (Wells 211/19-2, 211/19-3 and 211/19-4) to the Murchison Platform (Figure 4.5).

Various items such as link-lock mattresses, grout bags and rock-placement have been used throughout each pipeline’s life to provide support and stability.

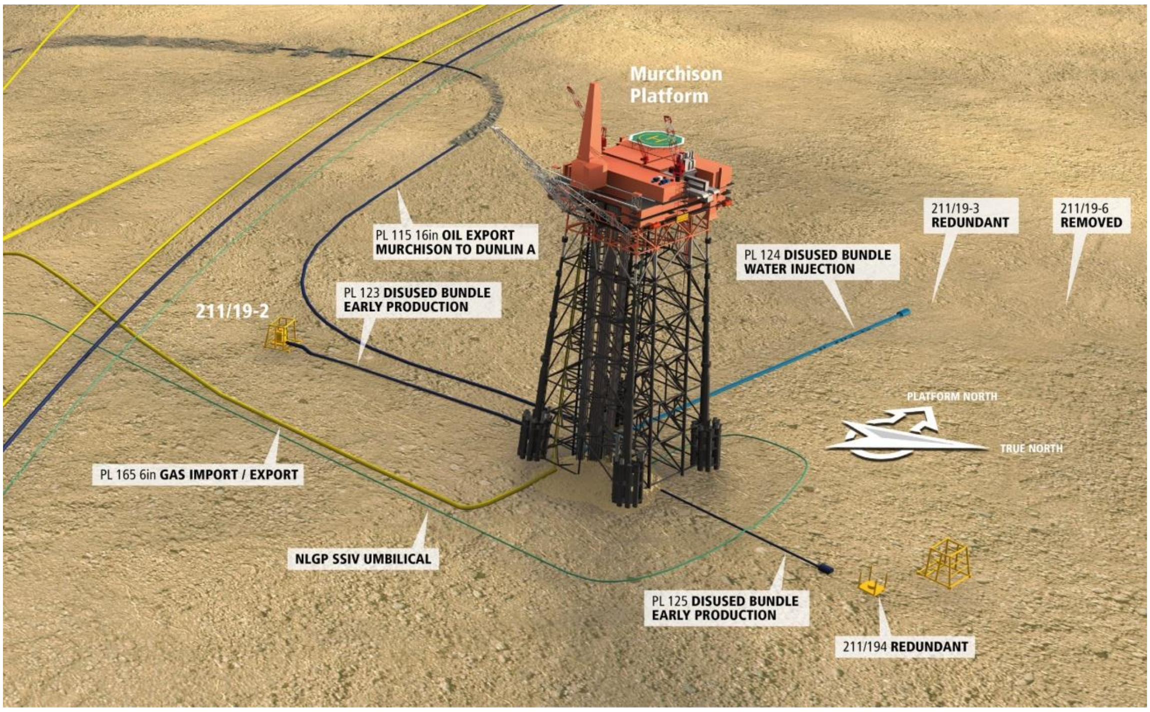


Figure 4.5: Schematic layout of the Murchison platform, pipelines and infield infrastructure

PL115 Oil Export Pipeline

Oil from the Murchison Field is exported to the Sullom Voe Terminal in Shetland via a 16” diameter pipeline (PL115) to the Dunlin A platform, which includes a riser to the Dunlin platform and topside facilities for transporting Murchison oil. The pipeline is approximately 19 km long, has a wall thickness of 15.9 mm and is constructed from Grade X60 steel. PL115 was designed to be trenched and buried, but approximately 45% of the pipeline length is exposed, with the remaining 55% covered with 63,000 tonnes of rock-placement which was required as scour protection at 13 intermittent locations along 10.6 km of the length of PL115 (Atkins, 2011a).

PL115 has six third party crossings along its length comprising four pipelines and an umbilical (Section 4.1.2; Table 4.1). All third party pipelines are live and are laid over the top of PL115. Sections of the Murchison oil export pipeline that are crossed by the live third party pipelines will be left in place. PL115 has approximately 226 sacrificial anodes along its length, with one anode positioned every 85 m.

PL165 Gas Import Pipeline and SSIV Murchison Control Umbilical

Murchison gas is imported or exported from the NLGP via a 6” spur pipeline (PL165). A dedicated 2.6 km subsea control umbilical connects the SCU on Murchison to the NLGP SSIV. The 6” spur and umbilical are owned by the NLGP partners (Magnus, 36%; Murchison, 18%; Thistle, 6%; and Statfjord UK, 40%) and, therefore, do not directly fall within the Murchison decommissioning scope of work. However, CNRI will consider the potential environmental impacts of cutting the gas export pipeline and umbilical adjacent to the Murchison Platform. The SSIV control umbilical runs between the Murchison platform and the NLGP SSIV tee, the umbilical is covered with rock protection along its length with the exception of the approaches to the Murchison platform. As part of the Murchison decommissioning, the umbilical will be separated from the platform with the exposed section of approaches being cut and recovered (0.5 km), the rock covered umbilical (1.8 km) will then be left in place for future decommissioning by the NLGP partners.

Subsea Wells and Pipeline Bundles

The Murchison Facilities have three abandoned subsea tie-back wells, 211/19-2, 211/19-3 and 211/19-4, which were connected to the Murchison Platform by pipeline bundles PL123, PL124 and PL125, respectively (Atkins, 2011a). The pipeline bundles are out of service and are 100% exposed on the seabed.

- The production well 211/19-2 is located approximately 0.8 km west of the Murchison Platform and was suspended in 1982. The bundle (PL123) is left in place connected to the wellhead. The wellhead protective structure remains in place (Atkins, 2011a).
- The water injection well 211/19-3 is located approximately 2 km north-northwest and was abandoned in 1982 at which time the wellhead and protective structure were removed. At this time the bundle (PL124) was disconnected from the wellhead, flooded with seawater and left in place (Atkins, 2011a).
- The production well 211/19-4 is located approximately 1.24 km north-northeast and was abandoned in 1984. At this time the bundle (PL125) was disconnected from the wellhead, flooded with seawater and left in place (Atkins, 2011a).

Inventory of Materials Associated with Pipeline Decommissioning

Table 4.5 provides a summary of the quantities of materials associated with each of the different pipelines and their associated support and protection structures.

4.2.4 Platform Wells and Conductors

Murchison has 33 well slots which are serviced by 27 x 760 m conductors and 6 x 660 m conductors which rise from the seabed through a combined conductor frame/guide to the well bay below the mezzanine level on the Murchison topsides where they terminate at the wellhead assembly. The well production casing and tubing is contained within the conductor and also terminates below the wellhead assembly.

The total number of development wells including sidetracks drilled to date from the Murchison Platform is 98; the 33 well slots currently house 18 active production and 13 water injection wells. Two wells have been partially abandoned due to integrity issues with the well bores.

Table 4.5: Inventory of materials covered by the scope of the Murchison pipeline decommissioning

Asset	Material	Weight (tonnes)
Pipeline PL115	Steel (pipeline)	3,266.1
	Concrete (pipeline)	3,648.1
	Concrete (mattresses)	320.0
	Concrete (grout bags)	Negligible
	Aluminium (anodes)	12.4
	Rock-placement	63,000
	Polypropylene (fronds)	Negligible
Bundle PL123	Steel	113.4
Bundle PL124	Steel	288.6
	Polypropylene (fronds)	Negligible
	Concrete (grout mats)	Negligible
Bundle PL125	Steel	177.8
	Sand (grout bags)	Negligible
	Concrete (grout bags)	Negligible
SSIV Murchison Control Umbilical - Exposed section connected to Murchison platform only	Steel, plastic, copper	5.6
Wellheads (211/19-2 and 211/19-4)	Steel	100.0

Source: CNRI (2011b)

Inventory of Materials Associated with Well Decommissioning

Table 4.6 provides a summary of the quantities of materials that will be recovered during the Murchison well plug and abandonment campaign.

Table 4.6: Inventory of materials associated with platform well decommissioning

Facility	Material	Mass per well (tonnes)	Total Weight in 33 Wells (tonnes)
Tubing	Steel	190.5	1,592
Xmas Tree	Steel	5	165
Wellheads	Steel	2.3	75
9 5/8” Conductor	Steel	17.4	574
13 3/8” Conductor	Steel	21.9	723
20” Conductor	Steel	30.3	999
30” Conductor	Steel	99.8	3,295
Conductor	Cement	9.0	297

Source: CNRI (2011b)

4.2.5 Drill Cuttings Pile

During the life of the platform, 98 wells including sidetracks have been drilled in the Murchison Field. Oil based mud (OBM) was used and discharged with drill cuttings at 48 of the wells (ERT, 2008). A proportion of these discharged drill cuttings and drilling muds now exist as a mound on the seabed immediately below the jacket and cover the bottom bracing level of the jacket.

Multi-beam Echo Sound (MBES) mapping of the cuttings mound (ISS, 2011) estimated that the pile has a volume of 22,545 m^3 (Figure 4.6) and footprint area of 6,840 m^2. This figure excludes the platform legs but includes other general platform debris that may be present (e.g. dropped objects such as scaffold poles, welding rods, tools and gratings). The drill cuttings pile has a maximum height of 15.34 m beneath the southeast edge of the platform (ISS, 2011). The edge of the pile extends approximately 40 m northeast and 75 m southeast and has a clear northwest/southeast orientation which is aligned with the direction of the seabed current.

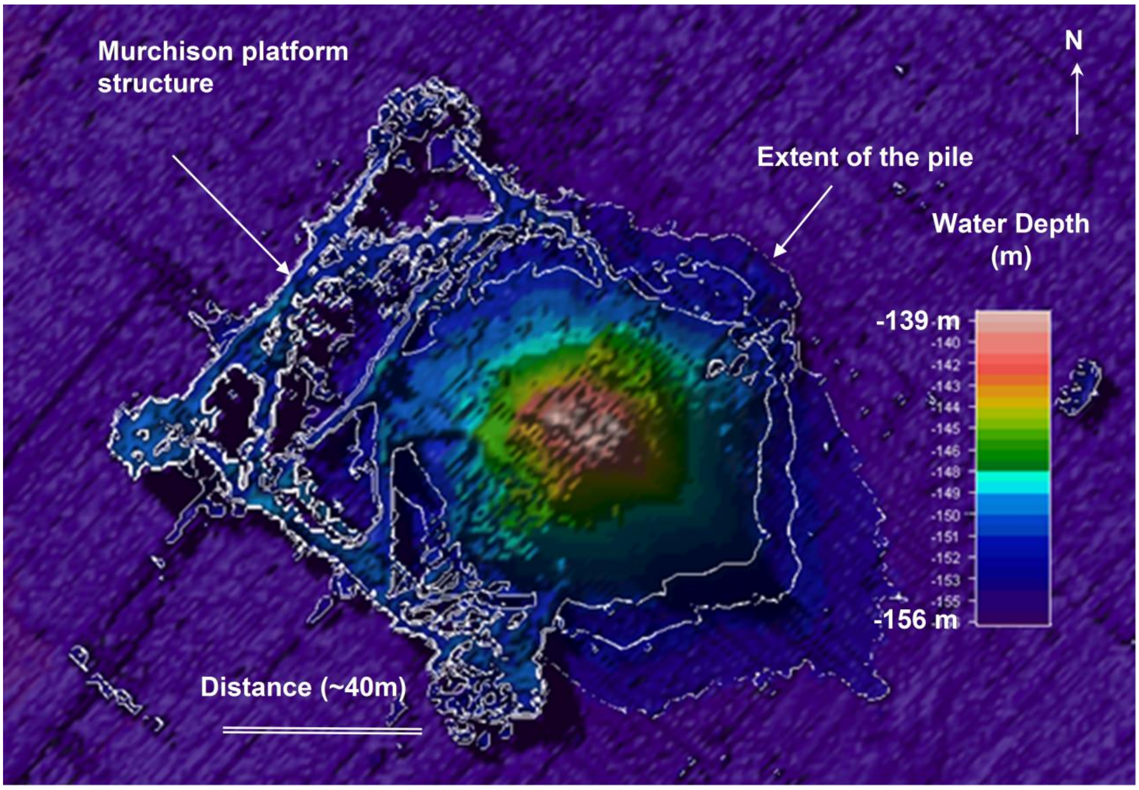


Figure 4.6: MBES survey data of the Murchison drill cuttings pile
Source: ISS (2011)

4.3 Assessment for the Decommissioning of the Murchison Facilities

4.3.1 Evaluation of Potential for Alternative Use of Murchison Facilities

During the initial planning stages for Murchison decommissioning, CNRI conducted a high level study to examine potential reuse and alternative uses for the Murchison Facilities (GL Noble Denton, 2011). The study examined the following possible uses:

- Tie-back/service provision to other fields.

- Reuse at alternative location.
- Offshore renewable energy generation (wind, wave or tidal).
- Carbon capture and storage (CCS).
- Offshore sub-station/hub.
- Non-energy sector alternatives:
    - Marine research station.
    - Metrology station.
    - Diver training centre.
    - Fish farm.
    - Communication and navigation centre.
    - Artificial reef.

Although a small number of disused offshore facilities have been successfully reused in other parts of the world, it is technically and economically difficult to achieve this in the North Sea where structures like Murchison are generally built for the specific requirements of the field they service. Several factors, including the remote location, difficulty of access, extreme weather, high maintenance costs, and the design life all influence the technical and economic viability of reuse and alternative use options for the Murchison platform. The Noble Denton study concluded that:

- the reuse of the Murchison jacket at another site is unfeasible due to the condition, size and age of the platform;
- there are no commercial oil and gas reserves that could be economically accessed to extend the life of the Murchison Platform;
- alternative use of the platform for offshore renewable energy generation would not be commercially viable as the capital outlays combined with annual operational and maintenance costs would far outweigh the revenue from energy generation; and
- the remoteness of Murchison and the limited revenue associated with the remaining options would not be expected to support the operating and maintenance costs associated with the platform (GL Nobel Denton, 2011).

4.3.2 Overview of the Options Available for Decommissioning

This section describes the viable options that CNRI considered for the decommissioning of the Murchison Facilities and which therefore will be covered by this EIA. Decommissioning options for the jacket, pipeline and drill cuttings pile were subject to a formal CA to determine which decommissioning options should be selected for the Murchison Facilities. Table 4.7 provides a summary of these options.

Removal of the topsides and jacket in a single piece was studied but has been discounted; the top of the jacket is too wide to permit the *Pieter Schelte* (the only vessel currently under construction which would have the lifting capacity to remove the topsides in their entirety) to position itself under the topsides (Allseas, 2011).

Table 4.7: Overview of short-listed decommissioning options for each facility

Murchison Facility	Decommissioning Option	Method
Wells	Plug & Abandonment (P&A) and conductor recovery to 31 m	
Topsides	Full removal	Reverse installation
		Piece-small
Jacket	Full removal	Cut and lift
		Flotation in one piece
	Partial removal	Cut and lift
		Flotation in one piece
Pipeline PL115	Full removal leaving crossings *in situ*	Cut and lift
	Removal of exposed sections	Cut and lift and bury ends
	Bury exposed sections and remove spools at Murchison and Dunlin A	Burial by trenching
	Bury exposed sections and remove spools at Murchison and Dunlin A	Burial by rock-placement
	Minimal removal of spools at Murchison and Dunlin A and bury ends	Cut and lift
	Leave *in situ*	No removal
Bundles PL123, PL124, PL125	Full removal (Bundles will be cut at the bundle towhead. The towhead is attached to the inside the Murchison jacket footings, and considered integral to the jacket structure and this towhead will not be removed at decommissioning)	
Subsea wellheads	Full removal	
Cuttings pile	Full removal	Separation, treatment of liquids offshore, transportation and treatment of solids onshore
		Transport slurry to shore, separation and treatment onshore for disposal
		Offshore injection of slurry
	Leave *in situ*	No removal
	Dispersion/redistribution offshore	

4.3.3 Overview of the CA Process

Under the Petroleum Act 1998 and as described in the DECC Guidance Notes (DECC, 1975), detailed CAs are required to identify the best overall option for decommissioning the:

- Murchison jacket, which falls within the category of structures that may be considered as a candidate for derogation from the general rule of “total removal” (OSPAR, 1998; Petroleum Act 1998);
- PL115 oil export pipeline (Petroleum Act 1998); and
- drill cuttings pile which would have to be removed to allow complete removal of Murchison jacket footings (OSPAR 2006/5).

CNRI conducted a CA following the DECC framework for CAs, which outlines five main criteria by which each decommissioning option should be assessed (Table 4.8). Where appropriate, these five main criteria have been further defined into sub-criteria (CNRI, 2012a; Table 4.8).

The sub-criteria were selected in light of:

- The "matters to be considered" listed in the OSPAR framework and the DECC Guidance Notes.
- The range of safety, technical, environmental, societal and economic assessments and studies that CNRI decommissioning projects have undertaken or shall undertake.
- CNRI's Safety, Health and Environmental (SHE) Policy, CNRI vision and mission statements.

Table 4.8: The criteria and sub-criteria to be used in CNRI CAs

Criterion	Sub-criteria
Safety	Risk to project personnel offshore
	Risk to project personnel onshore
Environment	Impacts of operations
	Impacts of end points
	Total energy consumption (GJ) and CO_2 emissions
Technical	Technical feasibility
	Ease of recovery from excursion
	Use of proven technology and equipment
Societal	Commercial impact on fisheries
	Socioeconomic impacts – amenities
	Socioeconomic impacts – communities
Economic	Total project cost

The assessment of the performance of each decommissioning option against each of the DECC criteria and sub-criteria was informed by appropriate engineering, environmental, societal, safety and economic studies, which were completed either by suitably experienced and qualified CNRI in-house personnel, or by suitably experienced and capable external organisations.

CNRI used a structured approach to compare each of the decommissioning options and to balance their performance across the different assessment criteria and sub-criteria in order to identify the overall recommended option.

Section 4.5 of this Project Description outlines and describes the methods associated with each of the options being considered for the decommissioning of the Murchison Facilities. The outcome of the CA process for the selection of the recommended option for decommissioning the Murchison jacket and pipelines is summarised in Section 4.6. The methods and outcomes for decommissioning the remaining Murchison Facilities, e.g. wells, topsides, subsea infrastructure and the drill cuttings pile are also summarised in Section 4.6.

4.4 Preparatory Work

This section provides a brief description of the preparatory work that would be carried out, regardless of which option was selected for decommissioning.

4.4.1 Post Cessation of Production Preparation for Murchison Decommissioning

During initial decommissioning activities, the Murchison Platform will remain manned for a period of approximately 24 months post Cessation of Production (CoP). During this period all utilities and life support services will be operational and maintained to support the following operations in the initial decommissioning phases:

- Well P&A and conductor recovery.
- Engineering-down and cleaning.
- Topsides preparation.
- Idle phase.

4.4.2 Well P&A and Conductor Recovery

Murchison decommissioning will commence with a phased well P&A campaign, which will be executed using the existing Murchison drilling derrick and facilities and using rig-less abandonment and conductor recovery technology. All wells will be abandoned in accordance with the Oil and Gas UK Guidelines for the Suspension and Abandonment of Wells (Issue 4, July 2012). At least two permanent cement plugs will be set within each well to provide tested barriers between hydrocarbon formations and the environment. Well abandonment from the Murchison Platform will be conducted in four phases:

- Phase 1: Bull Heading and Circulation. Circulate or bull head reservoir fluids out of the well bore and pump high density cement into place above the reservoir. If appropriate and completion components installed in the well allow, then the intermediate barrier will also be circulated into place during this phase.
- Phase 2: Coil Tubing Barrier Placements. Due to some of the well conditions reservoir isolation will be achieved by placing the required barriers through coil tubing to ensure isolation. If appropriate and the completion components installed in the well allow, then the intermediate barrier will also be circulated into place during this phase.
- Phase 3: Conventional Abandonment. Reservoir isolation will be achieved by removing the production tubing then setting the required barriers via a work string to ensure isolation of the reservoir. The intermediate barrier will also be placed via the work string.
- Phase 4: Tubing, Casing, Upper Barrier Placement and Conductor Recovery. A further surface abandonment plug will be set to complete abandonment of the well. CNRI intend to cut each conductor just above the conductor guide frame at elevation, at -125m (31 m above seabed). This would leave the conductor standing and supported at one end, by the seabed and the other end by its guide. The section of conductor left in place would be 31 m height, which

would be well beneath the top of the jacket footings, which would be cut at -112m (44 m above seabed). The lower conductor sections would terminate at a height 13 m below the top of the footings. Casing and conductors will be cut by either a mechanical or abrasive cutter and sections will be recovered to the surface for transport to shore. Marine growth will be cleaned from the conductors using a high pressure jet cleaner as they are pulled onto the platform.

4.4.3 Engineering-Down, Cleaning and Topsides Preparations

Engineering-Down and Cleaning (EDC) is the preparation work required on all systems, plant and equipment to ensure they remain, where possible, free of bulk hydrocarbons fluids, gases and hazardous materials. EDC shall ensure that during preparations and final removal of the topsides and jacket, no hazards from the production, operating or cleaning elements remain and that the topsides are handed over in a clearly defined and documented condition to facilitate future work.

Engineering-down involves the shutdown of all plant, equipment and systems - including electrical, instrumentation, piping systems and pipelines - which will enable the removal of any safety or environmental hazards prior to decommissioning activities. Prior to CoP, it is possible that EDC activities may commence on some of the systems or subsystems which are currently redundant (e.g. produced gas and associated systems). Following CoP, the remaining systems will be gradually shutdown following the Murchison decommissioning shutdown strategy. The EDC process will run concurrently with the well P&A and conductor recovery phase.

As a result of the proposed offshore cleaning work, the bulk of hydrocarbons, naturally occurring radioactive material (NORM), process chemicals, sand, scale, sludge and other contaminants shall be removed from within process systems.

CNRI propose that flushing, draining, venting and purging of the topsides will be sufficient to remove the majority of the mobile hydrocarbon inventories from the systems, minimise the safety and environmental hazards on the platform, and achieve a level of cleanliness acceptable to the contractors who will receive the waste onshore. No prescriptive standards exist for the required cleanliness of equipment to be returned onshore for reuse or disposal; this will be determined by CNRI based on industry experience, technical feasibility and their internal objectives and goals (WGPSN, 2011). The topsides will be prepared for removal by executing a variety of activities including: piece-small removal of loose or special items; separation of pipework, process equipment and utilities; installation of temporary safety and habitation systems (e.g. lighting, fire protection etc.); and the installation of lifting points.

EDC will be conducted over a 24 month period, with some activities taking place in parallel with well P&A. For approximately 2 months of the 24 month period, additional equipment will be required on the platform to complete the EDC and topsides preparation, including:

- 2 x diesel power generators
- 1 x diesel driven compressor
- 1 x diesel pump
- 1 x temporary crane

4.4.4 Idle Phase

After EDC, it is possible that the Murchison Platform will have to be put into an “idle phase” until the arrival of the topsides removal contractor. During this phase the platform will not be manned, but periodic inspections will be conducted to maintain the required temporary plant. This phase may last up to 24 months (CNRI, 2011c).

4.5 Options for Decommissioning the Murchison Facilities

This section describes the removal methods being evaluated for the dismantling and removal of the Murchison platform and the pipelines from their present locations and provides a brief outline of the engineering procedures that would be used for each method.

4.5.1 Topsides Decommissioning Options

The Murchison topsides modules will be completely removed and returned to shore for reuse, recycling and disposal. CNRI are considering two different options for the removal of the topsides. Whilst the topsides removal is not subject to a formal CA under the Decision or the DECC Guidance Notes, these options will be evaluated within the EIA so that the relative advantages and disadvantages of the different options for full removal can be compared and used in the internal CNRI decision-making process. The options being considered for topsides removal are:

- reverse installation; and
- piece-small removal.

Reverse Installation

Reverse installation would involve the removal of the topsides module-by-module. Modules would be separated from each other and then removed by a heavy lift vessel (HLV) and transported back to shore on the HLV or a barge for subsequent offloading, dismantling, reuse, recycling or disposal.

Module Separation

Prior to removal, modules would be separated by cutting the interconnecting primary and secondary steelwork, piping (such as small hydraulic control lines to oil and gas risers), electrical cables, air and exhaust ducting, walkways and stairwells that connect them. The following cutting techniques could be used:

- Plasma cutting for duplex/stainless steel.
- Flame cutting in the absence of hazardous materials.
- Cold cutting techniques such as air powered drill, reciprocating saw, bevel machine, diamond wire or shear cutter.

Preparation for Lifting

Access and rigging platforms would be installed to support the slings and to facilitate access to the sling eyes and lifting points. This would enable safe attachment of the slings and shackles.

New lift points would be installed if the original module lift points had been removed following installation; they would be installed in the same location as the original points to maintain the correct load path.

Since each module is secured to the module or support frame below it and to adjacent modules, “connecting” welds would have to be cut to allow modules to be removed independently. It might be necessary to install structural reinforcements, in areas where structural steel has been removed, to ensure that modules could be removed safely.

Module Lifting

An HLV would be used to lift the individual modules and structures from the topsides onto the deck of the HLV or onto cargo barges for transportation to shore. Appropriate sea-fastenings would be designed and installed to the HLV or barges.

Table 4.9 provides an overview of activities and types of vessels that would be required for reverse installation decommissioning of the Murchison topsides; durations and fuel consumptions are detailed in CNRI (2011d).

Table 4.9: Summary of activities and vessels required for topsides reverse installation

Sequence of events
Manufacture of approximately 1,500 tonnes of temporary steelwork
Mobilisation of vessels (HLV, 2 x HLV support vessels, supply vessel, standby vessel)
Preparation of topsides modules
HLV lift of topsides modules
HLV sailing to offloading location in sheltered waters
Mooring of cargo barge to HLV
Transfer of modules from HLV to cargo barge
Transportation and offloading of recovered modules to shore
Demobilisation of vessels
Dismantling of recovered material

Source: CNRI (2011d)

Piece-Small Decommissioning

“Piece-small” removal of the Murchison topsides would involve the offshore dismantling of the topsides modules using traditional cutting and lifting methods. Dismantled material would be loaded into containers on the platform for transportation by supply or cargo vessels to shore for reuse, recycling or disposal. Sorting of hazardous waste and cables/waste electrical and electronic equipment (WEEE) would be undertaken offshore prior to transportation, whereas sorting of steel scrap and other materials would be undertaken onshore at the disposal yard.

Removal Sequence

Piece-small topside removal would be conducted in three phases:

- In Phase 1, dismantling activities would be performed whist personnel were living in the existing accommodation on the platform.
    - All cables, cable trays, other non-steel materials such as accommodation interior and hazardous waste would be removed from each of the modules in turn.
    - Module internals such as vessels, pipes and secondary structures would then be removed with the use of hot/cold cutting, excavators or demolition robots.
    - The remaining module structures would be cut into container-sized sections.
    - The flare boom would be removed by an HLV.
- During Phase 2 an accommodation vessel would be mobilised as a temporary accommodation facility to enable the piece-small removal of the accommodation modules.
- In Phase 3 an HLV would be mobilised to remove the MSF in one piece.

<u>Cutting Techniques and Machinery</u>

The majority of gas cutting would be performed with a propane/oxygen mix, but in some cases where a propane mix is unsuitable due to steel thickness, oxy-acetylene would be used. Plasma cutting equipment would be used for all manual cutting of stainless steel.

Production pipes and equipment that may contain residual hydrocarbons would require cold cutting methods such as hydraulic or pneumatic saws, wire saws, and abrasive water jet cutting.

Several types of machinery might be used including excavators, hydraulic shears, electromagnet, trucks, demolition robots, crawler and platform cranes.

- Excavators are essential for the offshore piece-small dismantling of topsides. The use of excavators for cutting and handling of scrap would keep manual operations to a minimum. Excavators could be adapted to different work tasks by using long-reach booms and reinforced cabins which provide increased safety for the operator.
- Hydraulic shears are very efficient for cutting metals and could be used for the cold cutting of production pipes that may contain residues of hydrocarbons.
- Excavator-mounted electromagnets would be utilised for lifting and placing steel plates and for separating steel from other materials during the disposal phase.
- A compact loader would be used for internal transportation of equipment on the platform, particularly for transporting objects out of modules or other confined areas. Forklift trucks would also be used for material transport on the platform.
- In some cases demolition robots might be used in preference to manual demolition, as the small size of the robot makes it suitable for operations in confined spaces and allows operators to maintain a safe distance. The robots could be equipped with different types of accessories such as shears or buckets for use on a variety of jobs.

- Large lifts on the platform would be made using a crawler crane which is easy to move and has a long reach. The condition of the existing platform cranes is uncertain and new platform cranes would be needed. New cranes would be capable of lifting large objects, such as containers, onto support vessels for transportation to shore.

Table 4.10 provides an overview of the activities and types of vessels that would be required for piece-small decommissioning of the Murchison topsides; durations and fuel consumptions are detailed in CNRI (2011d).

Table 4.10: Summary of activities and vessel requirements for piece-small removal

Sequence of events
Manufacture of approximately 600 tonnes of temporary steelwork
Mobilisation of vessels and equipment, including HLV, cargo barge, supply vessel, standby vessel, tug, and portable electrical equipment
Piece-small offshore dismantling of topsides modules M2 to M7, M10 to M14, M17 and M19
Removal of flare boom by HLV lift
Mobilisation of an accommodation support vessel
Piece-small offshore dismantling of topsides modules M8, M9, M15, M16 and M91
HLV lift of accommodation block and MSF
Transportation of recovered modules to inshore
Inshore dismantling of recovered material
Demobilisation of vessels and equipment
Recovered material to recycling site or landfill

Source: CNRI (2011d)

4.5.2 Decommissioning Options for the Jacket

Since the Murchison jacket weighs more than 10,000 tonnes, it is a candidate for derogation under the Decision. Consequently, there are two main options for the decommissioning of the jacket – full removal and partial removal. CNRI have concluded that full and partial jacket removal could be undertaken by two options:

- Full removal:
  - cutting and lifting; and
  - flotation in one piece.
- Partial removal:
  - cutting and lifting; and
  - flotation in one piece.

Removal options for full and partial removal of the jacket use the same methods, equipment and techniques and only differ in the height of cut, the number of lifts and the maximum weights of lifted pieces.

Removal by Cutting and Lifting

The jacket members would be cut into sections using a combination of the cutting techniques described in the Cutting Methods Section. Each section would be held in place on the end of a lifting strop from a crane during cutting operations and would be lifted by an HLV after separation from the remainder of the jacket. Once sections had been separated and lifted to the surface, they would be sea-fastened and transported to an onshore disposal yard, either on dedicated transportation barges or on the HLV.

For both the full and partial removal options the upper section of the jacket, above the jacket footings, would be removed at approximately -112 m depth in several sections. CNRI have determined that this is the closest height above the top of the pile stick-ups[1] where the necessary cutting equipment can safely be deployed and positioned (CNRI, 2011b). In the full removal option, the jacket footings (including the pile clusters) would then be cut into sections and removed down to the seabed. The piles in the seabed would be cut at a depth of 3 m below the seabed so that the seabed was left clear of obstructions.

Removal by Flotation

Jacket removal by flotation using buoyancy tank assemblies (BTA) would be conducted in several phases. Initial preparatory work would involve cutting the majority of the foundation piles leaving enough in place to secure the jacket during installation of the BTAs. Support brackets would be fitted to each of the corner legs to secure the BTA units (Figure 4.7). Once the BTAs had been installed, both the BTAs and the flotation tanks within the jacket legs would be deballasted. Two tugs would keep the jacket on station while the remaining piles were cut, allowing the jacket to float free. It would then be towed to an inshore locationclose to the onshore yard for dismantling.

On arrival at the inshore grounding location the BTAs would be ballasted until the jacket rested on the seabed. The BTAs would then be removed, the inshore spread mobilised, and the jacket cut into sections weighing 800 to 1,400 tonnes. These would be transported to the demolition quay for further dismantling and then recycling. Table 4.11 provides a summary of the number of sections that the jacket would be cut into for the different decommissioning options being considered.

Table 4.11: Summary of jacket removal sections for each proposed option

Option	Full Removal (-156m depth)	Partial removal (-112m depth)
Cut and lift	1 - 12 sections	1 - 12 sections
Flotation	1 section	1 section

[1] OSPAR Decision 98/3 defines the footings of a steel jacket as those parts of a steel installation which are below the highest point of the piles which connect the installation to the seabed.

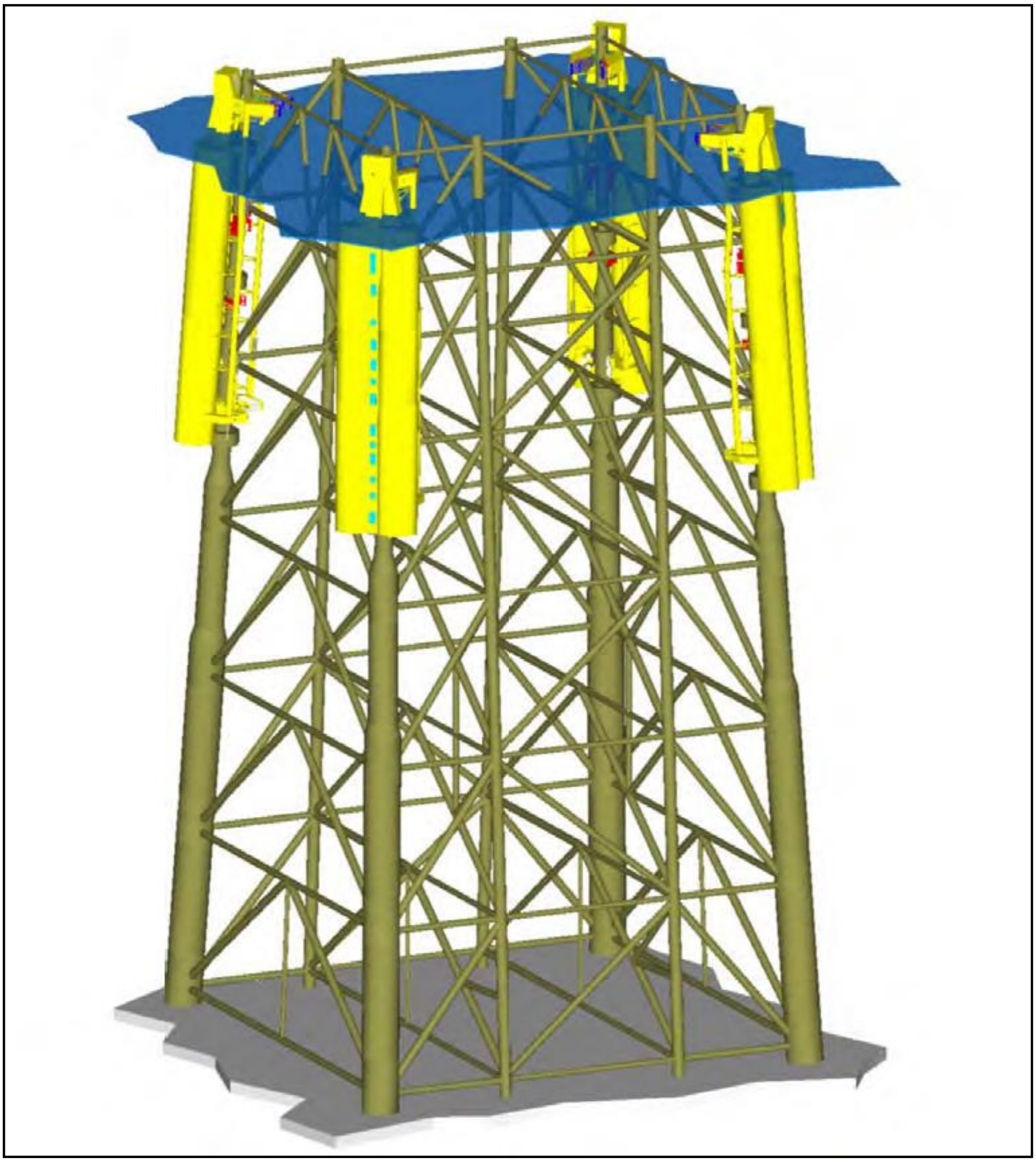


Figure 4.7: Modified BTAs installed on Murchison jacket

Source: Aker (2011)

Cutting Methods

It is likely that the programmes of work for both complete and partial removal would employ all of the following cutting methods:

- Diamond Wire Cutting (DWC). A diamond wire cutter uses a loop of steel wire bearing small beads embedded with diamond particles. DWC techniques will be used for jacket members with diameters larger than 1,400 mm and wall thicknesses up to 63 mm. The diamond wire is carried on a framework which is clamped onto the jacket legs to hold the wire in position during cutting.

- Abrasive Water Jetting (AWJ). An abrasive jet cutter produces a very high pressure jet of water mixed with grit. The jet is usually mounted on a carriage running over a rail clamped around the leg or brace to be cut. AWJ can be used for jacket legs with no internal stiffening or internal piping and piles (internal cutting). Both external and internal cutting machines are available.
- Hydraulic shear. Hydraulic shears are used for cutting smaller braces up to 1,400 mm diameter.

Both the internal AWJ and external cutting DWC manipulators will include a feature to perform a castellated and/or stepped cut. The use of castellations on the external AWJ manipulators is subject to the results of verification tests.

Use of Explosives: It is not anticipated that explosives would be required to cut jacket members or any of the associated subsea equipment.

Table 4.12 and Table 4.13 provide an overview of activities and types of vessels required for the full removal of the Murchison jacket; durations and fuel consumptions are detailed in CNRI (2011d).

Table 4.12: Summary of operations and vessel requirements for full jacket removal by cutting and lifting

Operations
Manufacture of approximately 350 tonnes of temporary steelwork
Mobilisation of vessel spread comprising HLV, construction support vessel (CSV) and standby vessel
Preparation of jacket top sections
HLV removal of jacket top sections
Transportation and offloading of jacket top sections to shore
Removal of cuttings pile
Preparation of jacket footings
HLV removal of jacket footings
Transportation and offloading of jacket footings to shore
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: CNRI (2011d)

Table 4.13: Summary of operations and vessel requirements for full jacket removal by flotation

Operations
Manufacture of 1,860 tonnes of temporary steelwork comprising modifications to the BTAs and support brackets for the BTAs
Mobilisation of vessel spread comprising two DP vessel with remotely operated vehicle (ROV), tractor tug, support vessel, standby vessel and shearleg crane vessel
Preparation of jacket
Transportation of BTAs to the field
BTA installation
Float up of jacket
Tow to inshore
Inshore dismantling
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: CNRI (2011d)

Table 4.14 and Table 4.15 provide an overview of activities and types of vessels required for partial removal of the Murchison jacket; durations and fuel consumptions are detailed in CNRI (2011d).

Table 4.14: Summary of operations and vessel requirements for partial jacket removal by cutting and lifting

Operations
Manufacture of approximately 350 tonnes of temporary steelwork
Mobilisation of vessel spread comprising HLV, CSV and standby vessel
Preparation of jacket top sections
HLV removal of jacket top sections
Transportation and offloading of jacket top sections to shore
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: CNRI (2011d)

Table 4.15: Summary of operations and vessel requirements for partial jacket removal by flotation

Operations
Manufacture of 1,860 tonnes of temporary steelwork comprising modifications to the BTAs and support brackets for the BTAs
Mobilisation of vessel spread comprising two DP vessel with ROV, tractor tug, support vessel, standby vessel and shearleg crane vessel
Preparation of jacket
Transportation of BTAs to the field
BTA installation
Float up of jacket
Tow to inshore
Inshore dismantling
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: CNRI (2011d)

Inventory of Materials Associated with Jacket Decommissioning

Table 4.16 provides a summary of the quantities of materials that would be recovered and left *in situ* for the different options being considered for the decommissioning of the Murchison jacket.

Table 4.16: Amounts of materials that would be left in place or recovered in different decommissioning options for the Murchison jacket.

Component	Installed weight (tonnes)	Partial Removal	
		Recovered weight (tonnes)	Mass left *in situ* (tonnes)
Total steel jacket	18,983	14,853	4,484
Piles	3,007	0	4,243
Grout	948	0	1,109
Anodes	126	386	115
Densitometers (no 72)	Negligible	0	Negligible
Conductor base (-125m)	5,591	4,855	736
Bundle Towheads attachment to Murchison jacket	18	0	18
Marine growth	1,536	1,305	1,089
TOTAL	**24,600**	**16,544**	**11,040**

Source: CNRI (2011b)

4.5.3 Decommissioning Options for the Pipeline

Pipeline decommissioning is governed by the Petroleum Act 1998 and the requirements are set out within the DECC Guidance Notes. The DECC Guidance Notes state that there are no prescribed options for pipeline decommissioning; all feasible options must be considered and a CA undertaken to determine which decommissioning option provides the most acceptable solution on the basis of the criteria set out in the DECC Guidance Notes. The pipelines would be cleaned as part of the EDC scope prior to their decommissioning.

This section outlines the methods that may be used to decommission pipeline PL115 in the Murchison Field. The bundles will be removed from the seabed following the recommendation in the DECC Guidance Notes that smaller diameter pipelines, including flexible flowlines and umbilicals which are neither trenched nor buried, should normally be entirely removed. The potential decommissioning options being considered for the pipeline PL115 are:

- leaving *in situ*;
- burial *in situ*; and
- removal (both selective and total).

The three main decommissioning options have been further developed to provide the following six high level decommissioning scopes of work for pipeline PL115. There are five live pipelines and an umbilical which pass over the top of PL115; these crossings will be left in place until the live pipelines are themselves decommissioned. Therefore all options assume that the pipeline crossings are left *in situ*.

Option 1: Total Removal. Spoolpieces from the Murchison and Dunlin A approaches would be removed together with the protective mattresses. The section of pipeline which is covered by rock-placement would be cleared of rock and the pipeline removed by cut and lift.

Option 2: Removal of Exposed Sections. Spoolpieces from the Murchison and Dunlin A approaches would be removed, together with the protective mattresses. The exposed sections of pipeline which are not covered by rock would be removed.

Option 3: Burial by trenching. Spoolpieces from the Murchison and Dunlin A approaches would be removed, together with the protective mattresses. The entire pipeline would be buried by trenching. An ROV Support Vessel (ROVSV) or Dive Support Vessel (DSV) would be utilised to disconnect the pipeline ends, and remove and recover the spools to the vessel. A trenching vessel, using either a plough or jetting machine, would be used to bury the pipeline to achieve a cover of at least 0.6 m over the top of the pipe.

Option 4: Burial by rock-placement. Spoolpieces from the Murchison and Dunlin A approaches would be removed, together with the protective mattresses. The entire pipeline would be buried by rock-placement. Graded rocks would be placed using a rock-placement vessel or ROVSV at locations where the pipeline is exposed. It has been estimated that 53,000 tonnes of rock would be required to achieve sufficient burial.

Option 5: Leave *in situ*. Remedial work would be required to leave and maintain the pipelines and infrastructure in an acceptable condition. This would involve either rock-placement or re-trenching any spans or exposures along the buried sections of the pipeline.

Option 6: Minimal Removal. Spoolpieces from the Murchison and Dunlin A approaches would be removed, together with the protective mattresses. Remedial burial of spans and exposures along the buried sections of the pipelines would be required and would be achieved by rock-placement or re-trenching and burial.

Pipeline Removal Techniques

Cut and Lift: Sections of pipeline would be cut at the seabed using a large ROV equipped with specialist hydraulic guillotine cutting equipment. Cut sections of pipe would be lifted onto a support vessel and returned to shore for recycling or disposal.

4.5.4 Decommissioning Options Considered for the Cuttings Pile

In 2008 CNRI conducted a technical review of their North Sea assets with regard to the OSPAR Recommendation 2006/5. The review estimated that the rate of loss of oil to the water column and area persistence for the Murchison drill cuttings pile were 2.46 tonnes/year and 55 km^2year respectively (ERT, 2008). As these characteristics were below the OSPAR thresholds (10 tonnes/year and 500 km^2year, respectively) it was concluded that no further action was required (ERT, 2008). This initial screening assessment was based on an estimated pile volume rather than an actual measurement and therefore the thresholds have been re-calculated using site-specific data and modelling techniques.

In spring 2011, CNRI conducted a pre-decommissioning environmental survey which included measurements of cuttings pile volume and total hydrocarbon concentrations. More recently, CNRI repeated the OSPAR Stage 1 screening process for the Murchison cuttings pile using the results from the pre-decommissioning environmental survey to re-calculate the area of persistence and rate of oil loss (Section 10). Results of the Stage 1 assessment indicated that the characteristics of the cuttings pile are below the OSPAR thresholds.

The Murchison jacket footings are, however, embedded within the drill cuttings pile which is almost wholly located within the base of the jacket structure. Therefore it is necessary to consider the different methods of removing the drill cuttings pile in order to access the jacket footing for removal. The drill cuttings pile management options under consideration for removal of the Murchison drill cuttings pile are:

- Excavation of drill cuttings to the surface, separation, treatment of liquids offshore, transportation and treatment of solids onshore.
- Excavation of drill cuttings to the surface, transport slurry to shore, separation and treatment onshore for disposal.
- Excavation of drill cuttings to the surface and offshore injection of slurry.
- Excavation of drill cuttings and dispersion/redistribution offshore.
- Leave *in situ.*

4.5.5 Onshore Dismantling and Disposal

Methods Available for Dismantling

The onshore decommissioning yard where the Murchison Platform will be dismantled for recycling and disposal has not been identified; it will be determined during the platform removal contracting process. Whilst the specific dismantling activities and location for the Murchison Platform cannot be detailed at this stage of the project, the likely operations that would be conducted during the onshore dismantling of the installation have been identified.

Many of the dismantling operations would be common to both the jacket and the topsides; however, the potential for the presence of very small amounts of residual hazardous substances is unique to the topsides, and the large size of the jacket members makes dismantling this structure technically difficult. All the operations relating to the dismantling, handling, storage, transportation and disposal of materials or structures onshore will be covered by the provisions of existing legislation in the UK or Norway.

Prior to transportation to the dismantling yard, the platform would be cleaned during the EDC process (Section 4.4.3) so that only residual amounts of material and hydrocarbons remained in vessels and pipework.

Operations Onshore to Dismantle the Topsides

Dismantling of the bulk of the topsides onshore would probably be undertaken using remotely controlled hydraulic shears to minimise the safety risks for onshore personnel. The use of gas-cutting may also be appropriate. Other equipment required for the dismantling operations would include: tower cranes, crawler cranes, long-arm and short-arm hydraulic nibblers, bobcats, power plants and possibly burning equipment.

It is possible that small amounts of residual hydrocarbons or environmentally hazardous liquids may be released during these operations. Such releases may include substances that were not found during the pre-dismantling investigations. Appropriate bunding shall be in place around the dismantling pad and an emergency response plan would be prepared to deal with any such contingencies.

Operations to Dismantle the Jacket and Footings

The steel jacket will be dismantled using a combination of “hot” and “cold” cutting techniques. Depending on the decommissioning methods selected, some of the sections from the jacket will weigh up to 2,000 tonnes, and their dismantling will present considerable technical and safety challenges.

It may be necessary to remove the remnants of any marine organisms that may still adhere to the steel structures, if these present a safety, hygiene or environmental hazard during the onshore dismantling process.

The dismantled equipment and structural components may be stored on site before removal to recycling centres or to final disposal sites. All hazardous equipment and structures shall be stored in a specifically designed and secure compound. This compound shall be appropriately isolated from the environment, especially surface and ground water.

All material arising from the dismantling process will be transported from the dismantling site for ultimate recycling or disposal. Materials may be removed by barge or lorry to recycling plants, incinerators or landfill sites, as appropriate.

Disposal of Material

CNRI will follow the principles of the waste hierarchy (Figure 4.8) in order to minimise waste production resulting from the Murchison decommissioning activities.

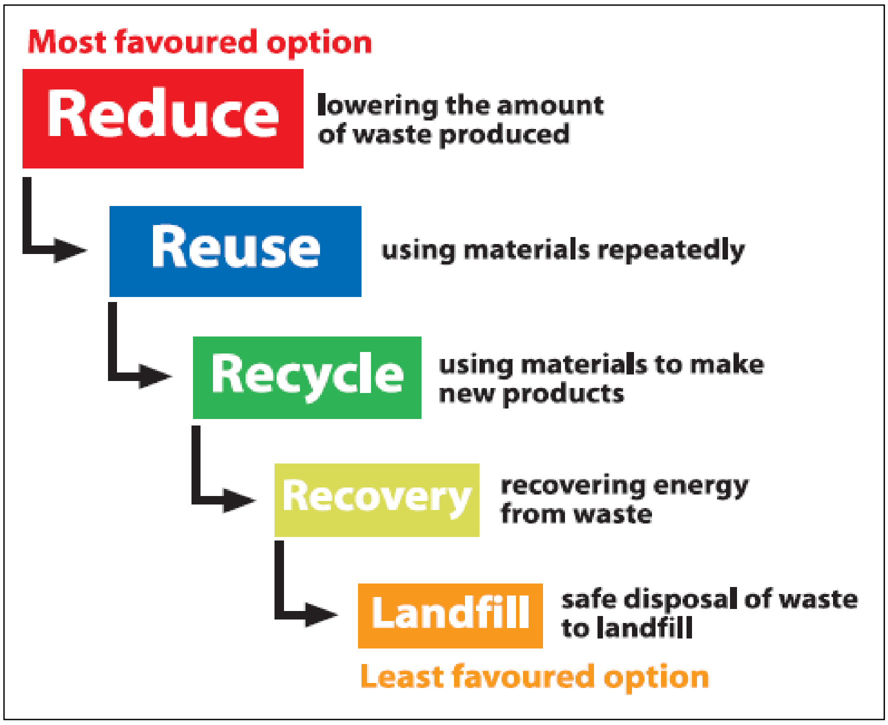


Figure 4.8: Waste Hierarchy

Source: http://www.wasteawarecampus.org.uk/hierarchy.asp

Reduce and Reuse Opportunities

CNRI have conducted an extensive review of operational equipment and components and identified over 500 items that could possibly be reused (CNRI 2011d). If possible CNRI will use some of these items on other CNRI assets, or they will be sold for reuse, either directly by CNRI, through a platform broker, or through the decommissioning contractor.

Recycling and Reprocessing of Waste Material

Non-hazardous materials, such as scrap metal, concrete, plastic and wood, that are not contaminated with 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 Murchison topsides, jacket, pipelines and well abandonment (Sections 4.2.1, 4.2.2, 4.2.3, 4.2.4). Recycling is therefore expected to be the most significant end point for materials recovered from the Murchison Platform.

Where necessary, hazardous waste resulting from the dismantling of the Murchison Platform shall be pre-treated to reduce its hazardous properties or, in some cases, render it non-hazardous prior to recycling or disposal to landfill. Under the Landfill Directive, pre-treatment will be necessary for most hazardous wastes which are destined to be disposed of to landfill sites. Other non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site.

4.5.6 Long-term Monitoring Requirements for Material Left in the Sea

CNRI would remain responsible for any components left in the sea as a result of an approved decommissioning programme, and some form of monitoring would be required. Any future monitoring programme would be undertaken following discussions and agreement with DECC. The duration, frequency and nature of any such monitoring would depend on the characteristics and state of the material left on the seabed (including the nature and amounts of any contaminants on or in the components) and also on future political and environmental concerns. It is therefore not yet possible to describe in detail what programmes might be undertaken to monitor structures; nor is it possible to describe the nature, extent and subsequent effects of any remedial activity that might be required.

4.6 Recommended Decommissioning Options for the Murchison Facilities

CNRI conducted a formal CA of the options for decommissioning the Murchison jacket and pipelines as described in Section 4.3.3, in order to determine the recommended option for each facility.

Table 4.17 provides an overview of the recommended decommissioning option for each of the Murchison Facilities, including those subject to a formal CA under the Petroleum Act 1998.

Table 4.17: Overview of recommended decommissioning options for each facility

Murchison Facility	Recommended Decommissioning Option	Possible Decommissioning Methods
Wells	P&A and conductor recovery	In accordance with the Oil and Gas UK Guidelines for the Suspension and Abandonment of Wells (2012)
Topsides	Full removal	Reverse installation
		Piece-small
Jacket	Partial removal	Cut and lift
		Flotation in one piece
Pipeline PL115	Burial	Remove spools at Murchison and Dunlin A and bury exposed sections by rock-placement
Bundles PL123, PL124, PL125	Full removal	Cut and lift
Subsea wellheads	Full removal	Cut and lift
Cuttings pile	Leave *in situ*	Natural degradation

For both the Murchison topsides and the jacket more than one decommissioning method is being considered for the recommended decommissioning option. The specific method for the decommissioning of these facilities will be determined during the contracting phase of the project; therefore, the impacts associated with all decommissioning methods for the recommended option will be assessed in this ES. Figure 4.9 provides an illustration of the Murchison Field post-decommissioning activities.

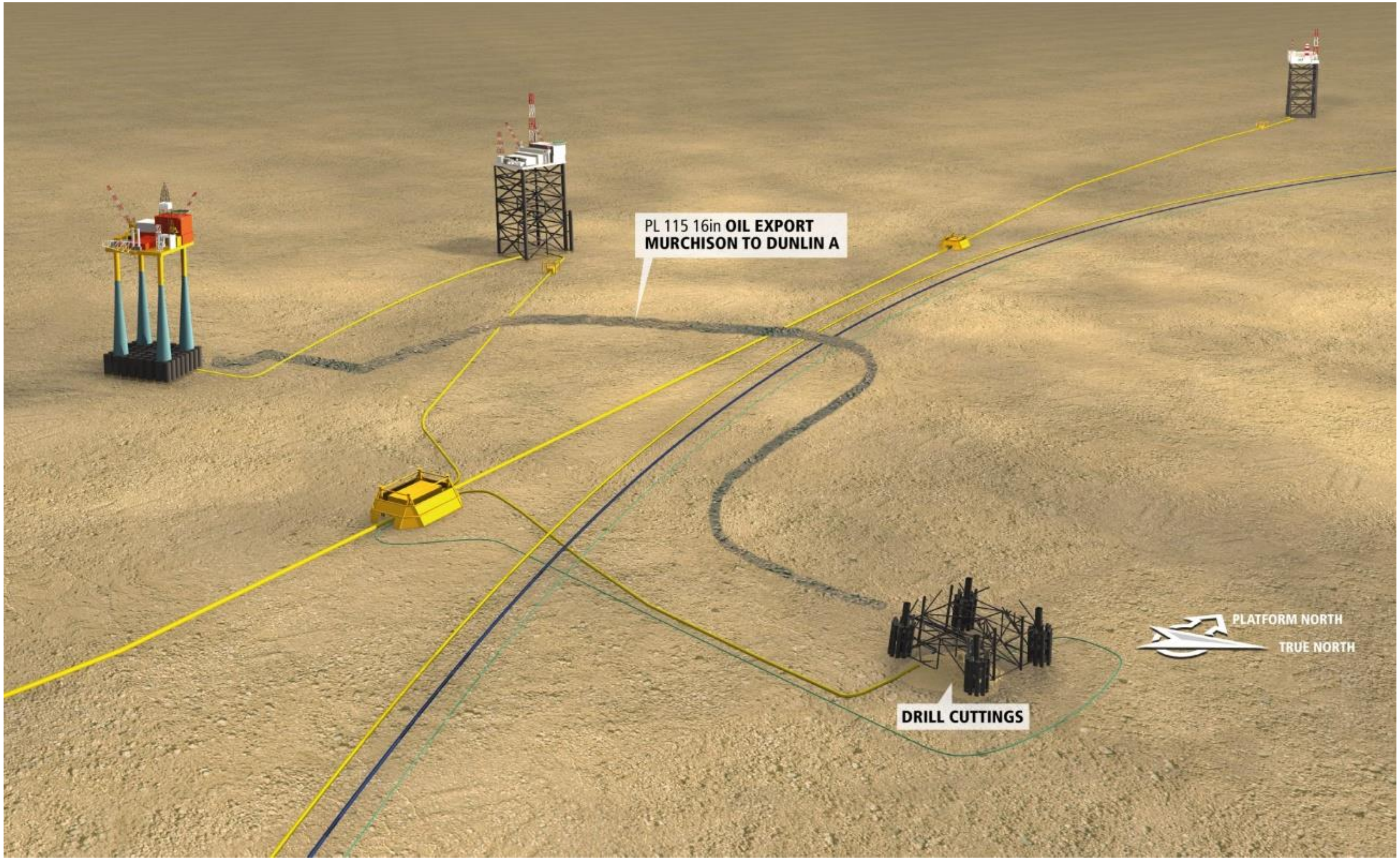


Figure 4.9: Schematic diagram of the Murchison Facilities layout post-decommissioning

5.0 ENVIRONMENTAL DESCRIPTION

The purpose of this section is to describe the environmental setting of the Murchison Facilities and assess the particular sensitivities in and around this location. An understanding of the environmental sensitivity informs the assessment of the risks associated with the proposed decommissioning of the Murchison Facilities.

The Murchison Facilities are located within UKCS Block 211/19, in an area of major oil and gas development and infrastructure (Figure 5.1).

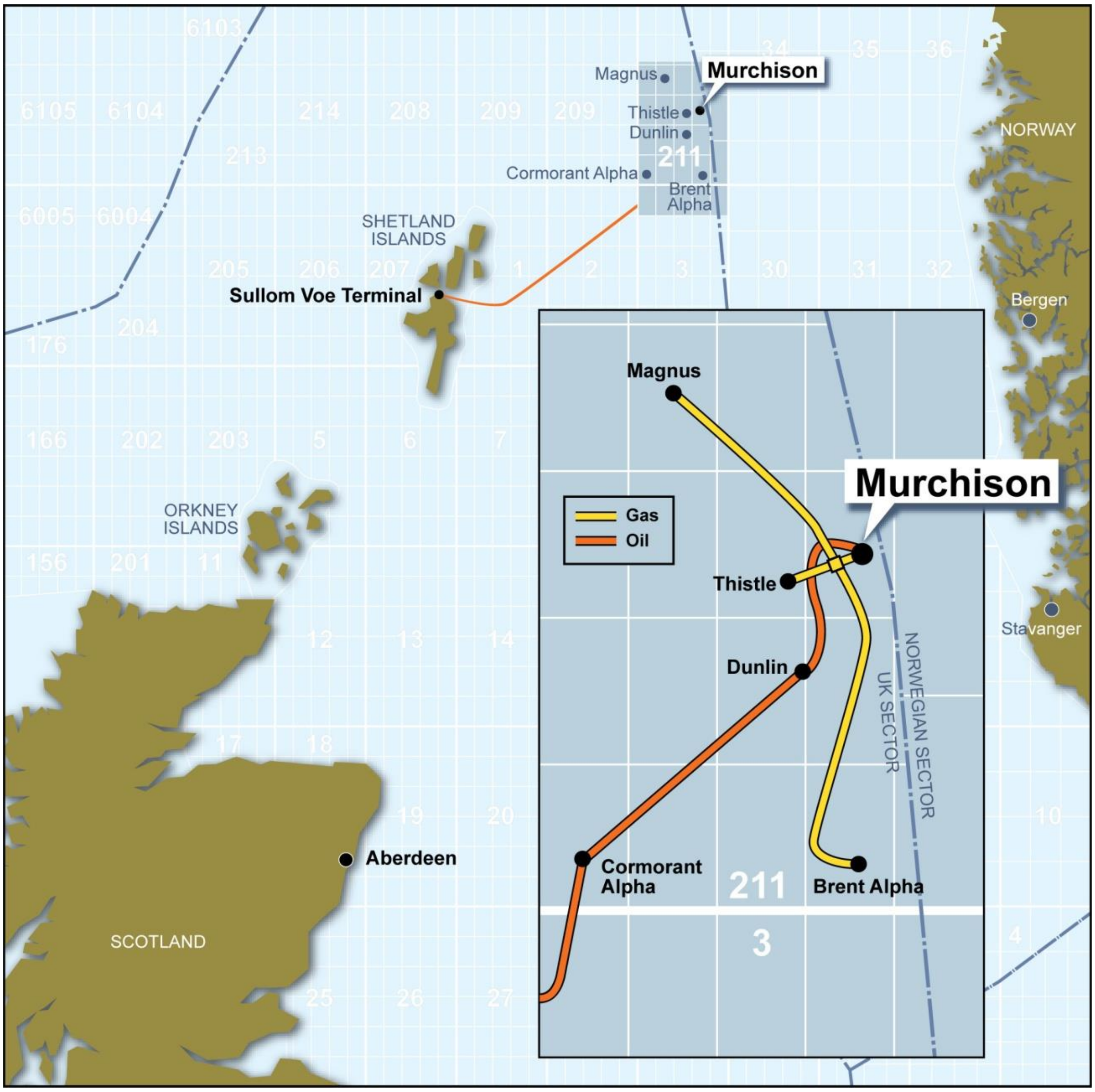


Figure 5.1: Location of the Murchison Facilities in the northern North Sea

5.1 Environmental Surveys

A pre-decommissioning environmental baseline survey and drill cuttings pile assessment for the Murchison Platform was conducted by CNRI in 2011 with the aim of determining the physical, chemical and biological character of the benthic environment in the vicinity of the Murchison Platform. Several other environmental surveys have already been carried out in the Murchison area in previous years. A summary of the surveys conducted to date is given below.

5.1.1 Murchison Pre-decommissioning Environmental Baseline Survey (2011)

In 2011 CNRI commissioned a pre-decommissioning baseline environmental survey at the Murchison Platform location. This was conducted by Integrated Subsea Services Limited (ISS), with sampling support from Fugro ERT, a division of Fugro GeoConsulting Limited in April/ May 2011 (Fugro ERT, 2013). The main survey objectives were to measure the footprint, dimensions, topography and volume of the cuttings piles and characterise the physico-chemical and biological status of the piles and surrounding sediments.

Grab sampling (using a dual van Veen grab) was completed around the platform based on a cruciform plan with the major transects aligned to the main residual current. Twenty eight stations were sampled, including reference stations positioned 10,000 m from the platform (Figure 5.2). Three inner push core samples were collected by ROV from the cuttings pile. Acoustic and ROV surveys of the seabed, pipelines and infrastructure were also conducted (ISS, 2011). *Lophelia pertusa* samples were collected by ROV from the legs of the Murchison Platform at a depth of 156 m. An MBES and side scan sonar (SSS) fitted to the ROV was used to produce a debris map of the 500 m area and identify any possible targets, such as seabed features, for further investigation (ISS, 2011).

5.1.2 Murchison Platform ROV Structural Inspection Report (2010)

In July 2010, an underwater inspection of the Murchison Platform was carried out using an ROV (ISS, 2010). The survey included:

- measurements of marine growth using an ROV mounted probe;
- bathymetric mapping of the drill cuttings mound;
- bathymetric mapping to indicate level of scouring around the platform; and
- a debris survey.

5.1.3 Murchison Platform Underwater ROV Surveys (2002, 2004, 2006 and 2009)

Marine fouling on the Murchison jacket was surveyed using an ROV in 2002, 2004 and 2006 by Subsea 7 and ISS. The aim of the surveys was to obtain measurements that would allow an assessment to be made of the composition, extent and thickness of the fouling layer on the jacket legs. Additional non-contact ROV footage was taken in 2009.

BMT Cordah was commissioned by Subsea 7 and ISS to carry out a marine growth assessment of the Murchison Platform using the ROV footage (BMT Cordah, 2010; BMT Cordah, 2004). The assessments included:

- A quantitative assessment of the percentage cover and thickness of the main fouling organisms over specified depth zones on the platform jacket.
- Determination of the extent of the cold-water coral species *Lophelia pertusa* on the platform conductors.
- Calculation of the average thickness of hard and soft marine growth at each depth zone on the platform jacket.
- A CA of the extent of marine growth in different survey years.
- A prediction of the extent of marine growth expected over 1, 3 and 5 years.
- An estimate of the weight and volume of marine growth in 2006 and *Lophelia pertusa* in 2009.

5.1.4 Assessment of Drill Cuttings Piles with Respect to OSPAR 2006/5 Recommendations (2008)

ERT (2008) carried out a screening assessment of the state of the Murchison drill cuttings pile. This was in response to the Department of Business Enterprise and Regulatory Reform's (BERR) implementation of OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles, introducing a two-stage approach to the management of drill cuttings piles. The first stage requires the operator to screen existing cuttings piles against established OSPAR thresholds to establish whether the rate of oil loss to water column or the persistence over the area of seabed contaminated exceeds OSPAR thresholds.

The ERT (2008) study estimated:

- the volume of the Murchison cuttings pile;
- the rate of oil loss from the cuttings pile;
- the surface area of contamination, defined as the area within which surface oil concentration exceeds 50 mg/kg; and
- the persistence of the contamination.

These estimates were made based on historical environmental survey data (UK Benthos, 2004; Section 5.1.6) and regression analysis carried out by BMT Cordah (2002) and UKOOA (2005) to establish statistical relationships between cuttings pile volumes, contamination areas and leaching rates, and parameters such as number of wells, water depth and volume of discharged cutting for fields for which this data was available. These statistical relationships were then used to infer the cuttings pile volume, contamination area and leaching rate for the Murchison Field. It was therefore stated that the results of the Murchison cuttings pile assessment should be "treated with caution" (ERT, 2008).

5.1.5 Murchison Field Survey (2006)

In 2006, a survey of the Murchison Field was carried out as part of a series of studies commissioned by the UK Government/Industry Environmental Monitoring Committee to obtain data on the long term trend in contaminant persistence and biological recovery around established producing oil and gas fields (Hartley Anderson Limited, 2007). Grab sample data was collected at six sampling stations in the Murchison Field at a distance of 250 m to 8,000 m from the Murchison Platform. The grab sample data was analysed to provide information on the sediment particle size, organic matter, hydrocarbon content, metals, radiochemistry and macrofaunal assemblage.

5.1.6 Environmental Surveys (1978 – 1993)

The Murchison Facilities area has been subject to nine environmental surveys which were conducted by Conoco UK whilst operator of the field between 1978 and 1993 (UK Benthos, 2012). These are listed in Table 5.1 with a summary of the chemical and biological analyses carried out.

Although historical baseline surveys (UK Benthos, 2012; Hartley Anderson Limited, 2007; ERT, 2008; ISS, 2010) were available for comparison with the recent baseline survey (Figure 5.2, Fugro ERT, 2013), the modification in the sampling design from previous surveys to account for subsea infrastructure and pipelines meant a detailed temporal data evaluation was not possible (Fugro ERT, 2013).

Table 5.1: Summary of environmental surveys undertaken between 1978 and 1993

Date	No. Stations	Sampling Gear	Chemistry / Biological Analysis	UK Benthos survey code
Aug-78	21	Van Veen; Day	-	MUR78
Apr-79	23	Van Veen	TOC, Metals (Ba, Cr, Fe), Bio	MRA79
Sep-79	23	Van Veen	TOC, Metals (Ba, Cr, Fe), Bio	MRB79
Aug-80	23	Van Veen; Agassiz	TOC, Metals (Ba, Cd, Cr, Cu, Pb, Va, Zn, Fe), Bio	MUR80
Sep-82	12	Van Veen	-	ND
Aug-85	11	Van Veen	TOC, Metals (Ba, Cr, Cu, Ni, Pb, Va, Zn, Fe), PAH, Bio	MUR85
Jul-87	25	Van Veen	TOC, Metals (Ba, Cr, Ni, Pb, Va, Zn, Fe), PAH, Bio	MUR87
Aug-90	24	Van Veen	TOC, Metals (Ba, Cr, Ni, Pb, Va, Zn, Fe), PAH, Bio	MUR90
Sep-93	35	Van Veen	TOC, THC, Metals (Ba, Cd, Cr, Cu, Ni, Pb, Va, Zn, Fe, Hg), PAH, Bio	MUR93

	TOC	Total Organic Carbon
	PAH	Polycyclic Aromatic Hydrocarbons
KEY:	THC	Total Hydrocarbon Concentration
	Bio	Benthic fauna
	Va*	*Va does not occur in the periodic table and has been assumed to be Vanadium

Source: UK Benthos (2004)

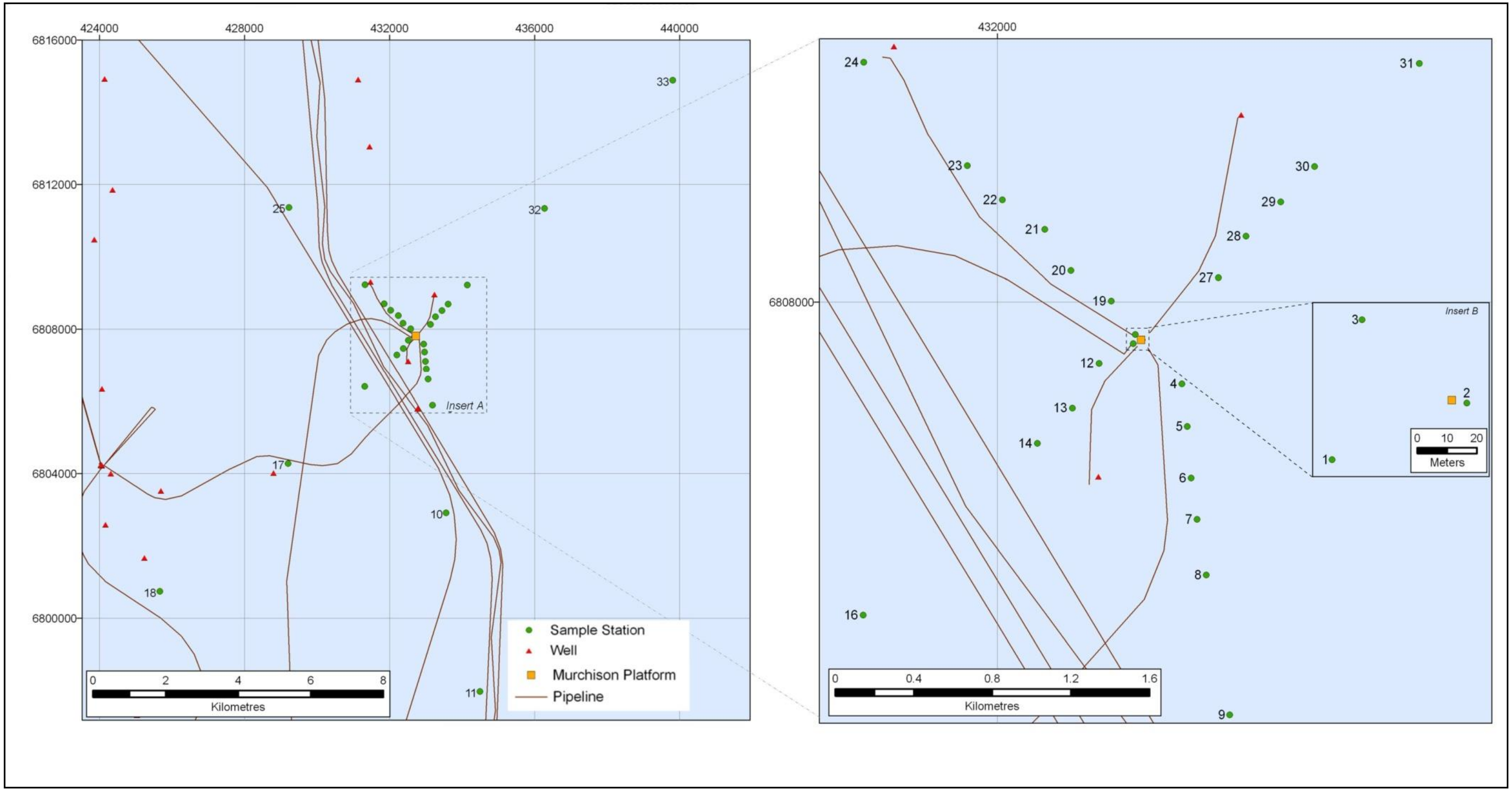


Figure 5.2: Sample locations for Murchison pre-decommissioning environmental seabed survey, April/ May 2011.

Source: Fugro ERT (2013)

5.2 Physical and Chemical Environment

5.2.1 Bathymetry

The North Sea basin is shallow varying from 30 m to 200 m, with the deep Norwegian Trench in the northeast margin reaching approximately 700 m depth. Water depth in the UK northern North Sea varies between 50 m and 200 m (NSTF, 1993).

Water depth at the Murchison Facilities is approximately 156 m (Figure 5.3). The seabed in the vicinity of the Murchison Platform is mainly flat with a northwards gentle slope from about 150 m to 200 m, although there is a rise in the east towards the Tampen ridge (CNRI, 2004).

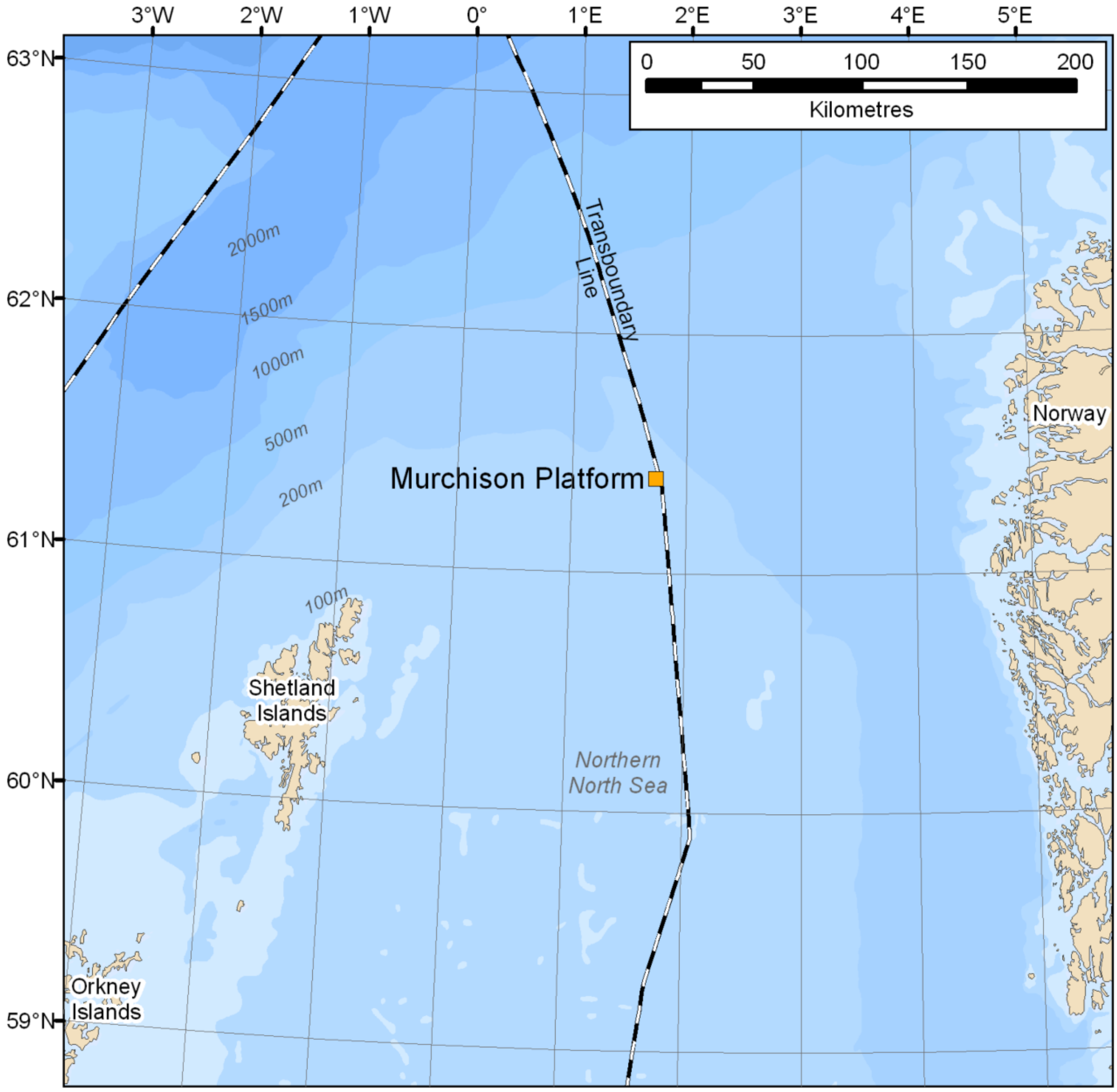


Figure 5.3: Bathymetry of the Murchison Facilities area

Source: Fugro ERT (2013)

The bathymetry recorded during the 2011 survey generally ranged from approximately 152 m to 162 m, although at the northeast reference station (station 33) the depth was 257 m. Overall, the seabed appeared to slope gently towards slightly deeper water (162 m) in the southwest with a much sharper drop in the northeast, from 153 m deep at 5 km from the platform to 257 m deep at 10 km from the platform (Fugro ERT, 2013).

5.2.2 Currents

Several water masses exist in the North Sea that are based on temperature, salinity and residual current patterns or stratification and which play a major role in the supply and dispersion of nutrients, plankton and fish larvae. The major water masses in the North Sea can be classified as Atlantic water, Scottish coastal water, northern North Sea water, Norwegian coastal water, central North Sea water, southern North Sea water, Jutland coastal water and Channel water (NSTF, 1993). The Murchison Field is located in the area influenced by the northern North Sea water mass.

Most of the inflows to the North Sea converge in the Skagerrak. The major flow consists of the Atlantic water that follows the 200 m depth contour to the north of the Shetland Islands before passing southwards along the western edge of the Norwegian Trench (Figure 5.4). Some of this water may pass southwards into the northern North Sea close to the eastern border of the Shetland Islands. A smaller flow, the Fair Isle Current, follows the 100 m depth contour, entering the North Sea between the Shetland and Orkney Islands. This flow is a mixture of coastal and Atlantic water that crosses the northern North Sea along the 100 m contour in a narrow band known as the Dooley Current, before entering the Skagerrak. The Norwegian Coastal Current constitutes the only outflow from the North Sea, which balances the various inputs of water to the North Sea. Circulation in the North Sea is enhanced by southwesterly winds; thus, circulation is normally stronger in winter than in summer (NSTF, 1993).

Over most of the North Sea, maximum tidal stream speeds vary from 0.25 m/s to 0.5 m/s and reach in excess of 1.0 m/s around the Orkney and Shetland Islands (UKDMAP, 1998). Tidal currents in the location of the platform are typical of the northern North Sea, with relatively weak surface current velocities and mean spring tides ranging from 0.26 m/s to 0.39 m/s (UKDMAP, 1998). Throughout the year the residual current speed ranges from 0.0 m/s to 0.01 m/s (UKDMAP, 1998). Prevailing seabed currents in the Murchison area run in a northwest to southeast direction (Figure 5.5).

5.2.3 Meteorology

In the vicinity of the Murchison Facilities winds vary seasonally and are characterised by large variations in wind direction and speed, frequent cloud and relatively high precipitation. The annual wind rose which captured data collected in 3-hour intervals for the period March 1973 to December 2006 (Figure 5.6) indicates that winds in the Murchison Facilities area are multidirectional. Winds from the south, southwest and west are generally predominant from April to June. The wind regime changes from August to February when the predominant wind direction is from the north (Atkins 2011b).

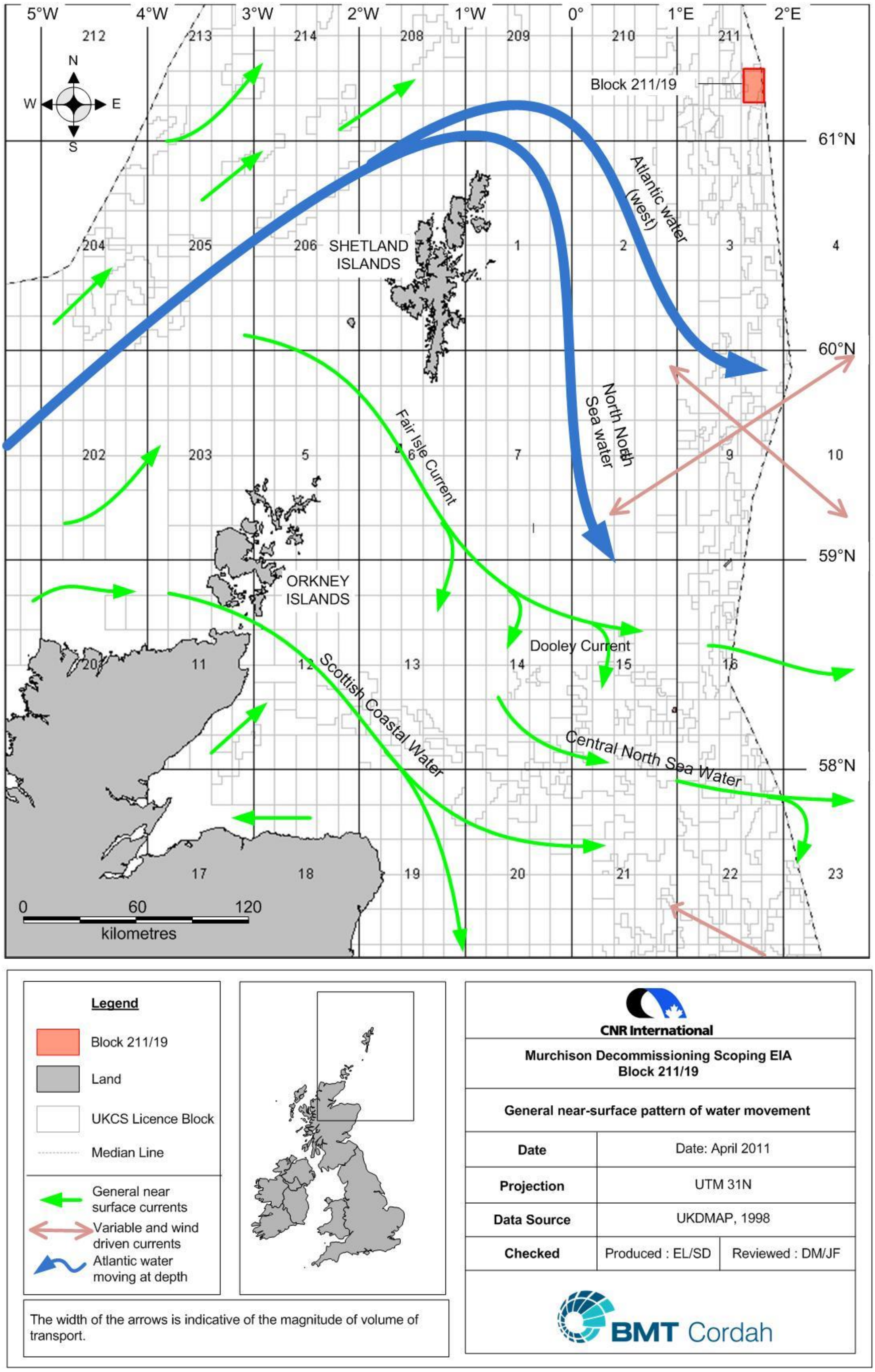


Figure 5.4: Current circulation in the vicinity of the Murchison Facilities

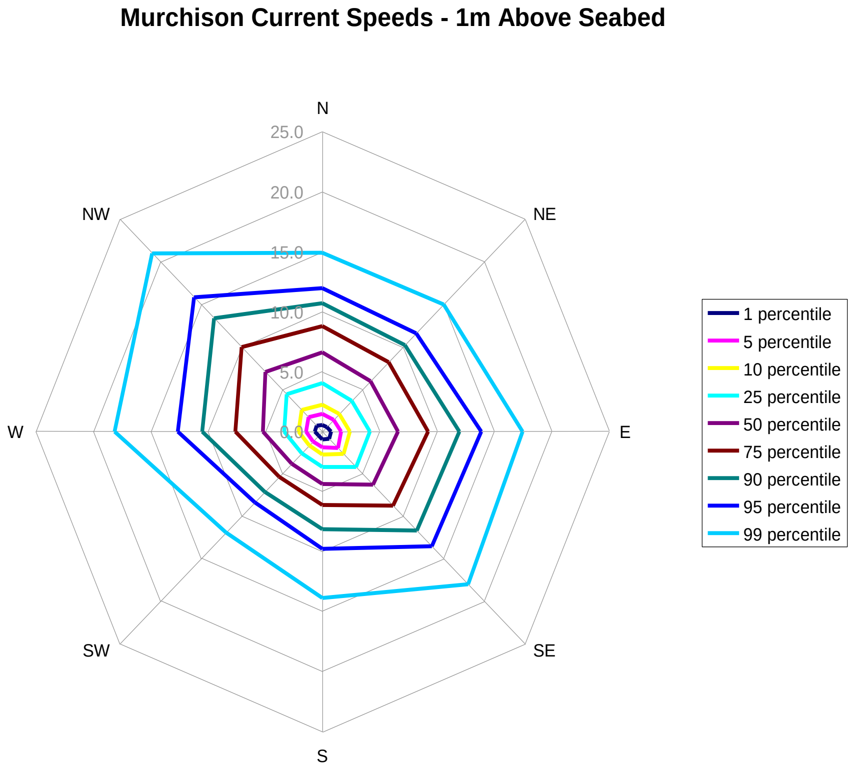


Figure 5.5: Predominant current speeds and directions at the Murchison Facilities

Source: Redrawn from Atkins (2011b)

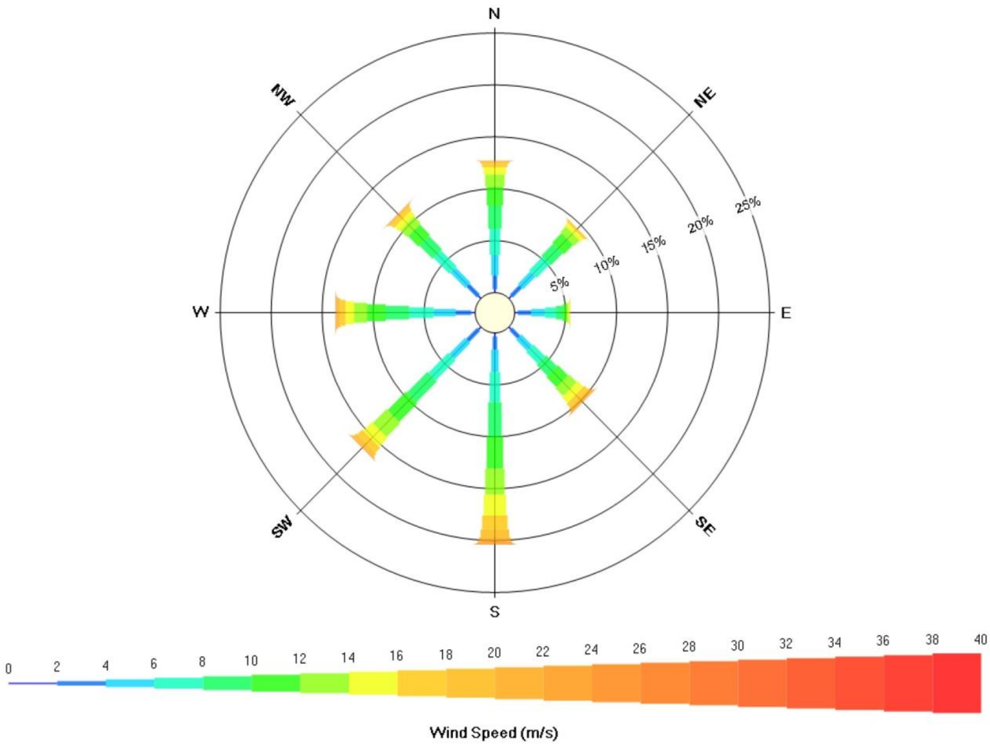


Figure 5.6: Annual wind rose in the vicinity of the Murchison Facilities (March 1973 to December 2006)

Source: Atkins (2011b)

5.2.4 Sea Temperature and Salinity

In the North Sea, water temperature is relatively uniform throughout the water column during the winter months. Over the summer months, the increase in solar radiation can result in a thermocline, which separates an upper warmer less dense surface layer from the denser cooler water below (Gill, 1982). The strength of the thermocline is determined by the intensity of the input of solar heat and wind and tide generated turbulence. The depth at which the thermocline occurs increases from May to September and is approximately 50 m deep in August/September in the northern North Sea (NSTF, 1993).

Table 5.2 provides information on sea surface salinity and temperature variation in the Murchison Field area. Mean sea surface temperature is around 12.5 °C in the summer and 8 °C in the winter. Mean bottom water temperature is less variable, at around 9 °C in the summer and 7 °C in the winter. There is little seasonal variation in the salinity of the water column in the Murchison Facilities area, which is around 35 ppm (UKDMAP, 1998).

Table 5.2: Typical values for temperature and salinity in the Murchison Facilities area

Parameter	Summer	Winter
Mean sea surface temperature/ ºC	12.5	8
Mean bottom temperature/ ºC	9	7
Mean sea surface salinity	35.2	35.3
Mean bottom salinity	35.0	35.2

Source: UKDMAP (1998)

5.2.5 Seabed Sediments

Sediment Types

Block 211/19 lies in an area of the northern North Sea where much of the sediment is fine to coarse sand (Kunitzer *et al*., 1992), constituting an approximate silt fraction of 5% and an organic fraction of 3% (Basford *et al*., 1990; Basford and Eleftheriou, 1989).

During the 2006 Murchison Field survey (Hartley Anderson Limited, 2007) sediment samples were taken at six stations at a distance of 250 m to 8,000 m from the Murchison Platform. Sediment in the Murchison Platform area at the sampling stations 500 m to 8,000 m from the platform stations was found to consist of poorly or very poorly sorted medium sands, with a mean diameter of 281 µm to 400 µm. In contrast, sediment at the station 250 m from the Murchison Platform comprised extremely poorly sorted coarse silt with a mean diameter of 45 µm. The proportion of fine material, defined as material with a diameter less than 63 µm, was low (< 7%) at all stations apart from the innermost station (54%). The organic content of the sediment was less than 1% at all stations apart from the two innermost stations (250 m and 500 m from the platform, respectively), where it was around 3% to 4%. The elevated proportion of fines, higher organic content and differing granulometry at the station closest to the platform were attributed to drilling activity at the platform.

During the 2011 survey the sediment type found throughout the Murchison Facilities area (grab samples) generally showed low variation with grain size diameter ranging from 122 µm to 483 µm (mean 333 µm) and was classified almost entirely as medium sand. Station 4 sediments had the lowest mean diameter (122 µm) and these were the only sediments classified as very fine sand. Given the proximity of station 4 to the platform, this potentially suggests an input of drill cuttings as a reason for the observed differences (Fugro ERT, 2013). The measured standard deviation values for the sediment grab samples ranged from 1.46 Φ to 2.90 Φ (mean 2.36 Φ), suggesting that the sediment was moderately to very poorly sorted, respectively. The maximum standard deviation value of 2.90 Φ was observed at station 4 indicating very poorly sorted sediment. The calculated skewness (Skq_{Φ}) values, -0.12 Φ to 0.83 Φ (mean 0.55 Φ) indicate that the grab sample sediments exhibited a tendency towards finer material (+ve skewness). The silt/clay content of the sediments showed little variation across the grab stations and ranged from <0.1% to 27.9% (mean of 5.9%) with the silt component dominating (*ca.* 75% of the total fines) in the samples. As with the mean diameter results the silt/clay content of station 4 sediments was also anomalous. Total carbonate (as calcium carbonate) and organic matter content in the grab station sediments ranged from 6.4% to 44.7% (mean 17.9%) and 0.5% to 8.7% (mean 1.3%), respectively. Total organic carbon levels for these samples ranged from 0.2% to 1.1% (mean 0.2%). A comparison of the sediment characteristics of station 33 (reference site) with the majority of the other grab samples showed no notable differences (Fugro ERT, 2013).

The inner push core samples (stations 1 to 3) taken from the cuttings pile in 2011 also showed relatively low variation with mean grain size diameters of 60 µm, 62 µm and 151 µm, respectively. The sediments at station 1 and station 2 were classified as coarse silt while station 3 was classified as fine sand. The standard deviation for the core samples showed very low variation between samples, 2.95 Φ, 2.98 Φ and 2.93 Φ for stations 1 to 3, respectively indicating very poorly sorted sediment. The silt/clay contents of the push core samples were 53.8%, 57.7% and 33.5% for stations 1 to 3 respectively, which highlighted the modification of the sediment at these locations with large quantities of silt from a background of medium sand. This is in contrast to the surrounding sediments in the Murchison Field which were classified as medium sand. Total carbonate and organic matter content in the push core sediments were 26.2%, 20.6%, 9.1% and 3.8%, 6.7%, 4.2% for stations 1 to 3, respectively. Total organic carbon levels for the push core samples were 1.3%, 5.3% and 1.5% for stations 1 to 3, respectively (Fugro ERT, 2013).

Seabed Features

During the 2011 survey, the seabed features were dominated by the Murchison Platform, cuttings pile and associated pipelines that run from the platform. There was no evidence of bedrock or biogenic reefs, pockmarks or unusual or irregular bedforms (Fugro ERT, 2013). Across the 500 m ROV survey zone the site had a large amount of seabed debris most likely related to previous activity at the Murchison Platform (e.g. wire spools, cables, scaffolding) along with numerous boulders. Full details, including detailed images, can be found in the acoustic survey field report (ISS, 2011).

Cuttings Pile

An MBES survey was conducted in 2011 in order to acquire sufficient data to map the drill cuttings pile below the Murchison Platform (Figure 5.7). The majority of drill cuttings were located under and to the southeast of the platform spreading out in a southeasterly direction following the main residual current (Fugro ERT, 2013; ISS, 2011). The seabed/pile base contour plane (i.e. the level taken to be where the drill cuttings pile and seabed level merge) was at a depth of 154 m while the top of the cuttings pile was at 138.66 m, giving an overall pile height of 15.34 m (ISS, 2011). The Murchison cuttings pile surface area and volume of the mound were calculated as 6,840 m^2 and 22,545 m^3 respectively, based on the MBES topography mapping of the cuttings pile (ISS, 2011). The pile sits firmly against and around the eastern leg of the platform and any removal of the platform leg and accompanying structures would cause significant disturbance to the pile (Fugro ERT, 2013).

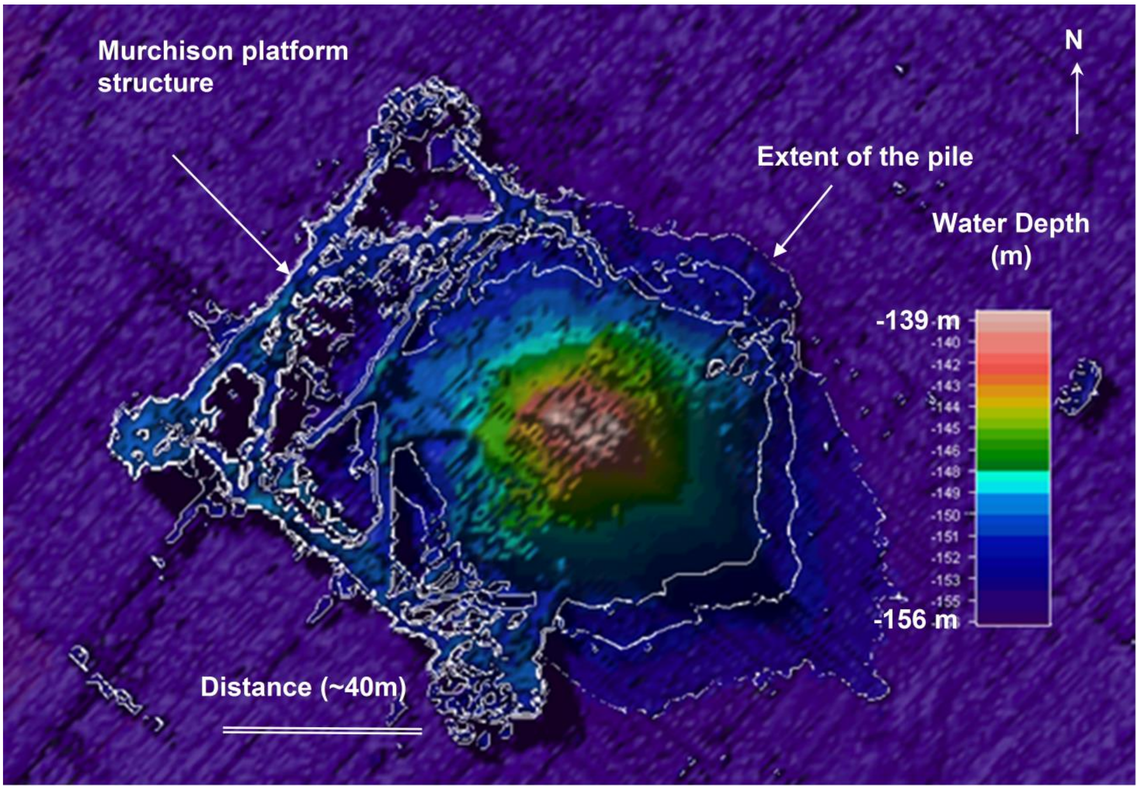


Figure 5.7: MBES survey data of the Murchison drill cuttings pile

Source: ISS (2011)

Three push cores were sampled from the Murchison drill cuttings pile for chemical and physical analysis and the results are compared with the contamination status found in the vicinity of the Murchison Platform (Table 5.3).

Seabed Chemistry

Chemical analysis of the seabed (concentrations of metals and hydrocarbons) provides an indication of the condition of seabed sediments in the area of the proposed operations. 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; however, contamination of the marine environment with crude oils is not a recent phenomenon, nor solely attributable to anthropogenic activities (Douglas *et al*., 1981).

Metals are generally persistent and most are toxic to varying degrees. Many essential metals such as copper, zinc and chromium 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 (Clark, 1996).

Metals typical of sediment contaminated with drilling muds or cuttings are barium, chromium, lead and zinc (Neff, 2004). By far 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 500 m from production platforms, but elevated concentrations of barium are found within 500 m to 1,000 m (CEFAS, 2001a). Monitoring sediment barium concentrations can provide information on the extent to which drill cuttings have been transported from their point of origin.

Table 5.3 shows typical values of contaminants found in surface sediments in the northern North Sea (CEFAS, 2001a), compared with expected background concentrations in “pristine” areas far from oil and gas installations (UKOOA, 2001; OSPAR, 2005a). The table also shows the concentrations found in sediment samples taken in the Murchison Platform area in 2006 (Hartley Anderson Limited, 2007) and grab and core samples taken in 2011 (Fugro ERT, 2013).

Surveys in 1985, 1987, 1990 and 1993 showed the characteristic effects of drilling discharges within approximately 1,000 m of the platform (Figure 5.8). Relative to the previous data, total hydrocarbon concentrations (THC) in 2006 at 250 m and 500 m were comparable to those found in 1993, which in turn were lower than in the data from 1985 to 1990. At distances greater than 500 m from the platform, there is little apparent change, with concentrations consistently close to background levels (UK Benthos, 2004; Hartley Anderson Limited, 2007).

In 2006, the THC at most sampling stations were within expected background levels for this area of the North Sea (Table 5.3). The THCs in the Murchison area were found to be moderately elevated at the innermost sampling station 250 m from the platform (86 µg/g) and slightly elevated (61.3 µg/g) at the station 1,000 m from the platform (Hartley Anderson Limited, 2007), relative to expected background levels of around 9.41 to 40.10 µg/g. This pattern of relative concentrations was reflected by the other hydrocarbon parameters. Gas chromatography traces indicated that the source of hydrocarbon contamination at the innermost sampling station was likely to be weathered diesel, while the source of contamination at the station 1,000 m from the platform was likely to be relatively fresh, lower molecular weight oil (Hartley Anderson Limited, 2007).

Table 5.3: Summary of contaminant concentrations typically found in surface sediments from the northern North Sea compared with those found within the Murchison area

Location	THC (µg/g)	PAH (µg/g)	PCB (µg/kg)	Ni (µg/g)	Cu (µg/g)	Zn (µg/g)	Cd (µg/g)	Hg (µg/g)	Ba (µg/g)
Estuaries	-	0.2-28	6.8-19.1	-	-	-	-	-	-
Coast	-	-	2	-	-	-	-	-	-
Offshore	17-120	0.2-2.7	<1	9.5	3.96	20.87	0.43	0.16	-
Oil & Gas installations	10-450	0.02-74.7	1,917	17.79	17.45	129.74	0.85	0.36	-
BC in northern North Sea (UKOOA, 2001)*	10.82 (20.32)	0.123 (0.341)	-	10.86 (12.40)	3.57 (5.40)	12.14 (13.00)	-	-	332.38 (637.50)
Maximum expected BC (OSPAR, 2005a)	-	-	-	30	-	90	0.2	0.07	
Murchison survey in 2006 (min-max)	5.5–86.1	0.037–0.728	Not available	1–15	2–67	11–1110	< 0.1–1.6	<0.05-0.942	111-1950
Murchison grab samples in 2011 (min-max (mean))	1.0-450 (24.8)	0.03-2.4 (0.16)	<0.10-0.56 (0.11)	2.85-25.2 (5.23)	1.85-146 (10.8)	5.77-628 (62)	<0.03-1.58 (0.13)	<0.03-2.33 (0.40)	36.8-2341 (442)
Drill cuttings core 1	1,310	14.0	0.44×10^{-6}	50.4	237	753	5.74	1.73	117
Drill cuttings core 2	10,100	65.8	0.73×0^{-6}	25.3	59.8	523	0.99	3.89	506
Drill cuttings core 3	2,590	14.6	0.9×10^{-6}	24.6	96.7	610	2.30	2.86	262

*OSPAR (2005a) (BC) - maximum expected background concentration, normalised to 5% aluminium if the environment were pristine

* mean BC (µg/g), [bracketed value represents the 95th percentile]

Source: CEFAS (2001a); UKOOA (2001); OSPAR (2005a); Hartley Anderson Limited (2007); Fugro ERT (2013)

Concentrations of metals in 2006 were elevated with respect to expected background concentrations at the innermost sampling station (Table 5.3). Zinc and barium concentrations were also elevated at the station 500 m from the platform. In general, there was a pattern of decreasing metal concentration with distance from the platform. The results suggest contamination by drilling discharges at the innermost sampling station (Harley Anderson Limited, 2007).

From the Murchison Field Survey data, ERT (2008) estimated that the “effect footprint” of the Murchison cuttings pile, defined as the region within which hydrocarbon concentration is greater than the OSPAR threshold of 50 mg/kg (see Section 5.1.4), extended to less than 500 m from the platform. This concurs with the results presented above (Hartley Anderson Limited, 2007). Assuming a circular area of impact, this corresponds to an effect footprint of 0.785 km^2 (ERT, 2008). The rate of leaching, or loss of oil to the water column, from the cuttings pile, was estimated as 2.46 tonnes/year and the persistence of the pile as 55 km^2/yr (ERT, 2008).

Table 5.4 summarises the results of sediment hydrocarbon analysis undertaken in the Murchison Platform area in 2011 (Section 5.1.1), with sampling stations at increasing distance from the platform. Table 5.5 summarises the results of PCBs, alkylphenol ethoxylates (APEs) and organotin analysis; and radionuclide levels in surface sediments. Table 5.6 summarises the metal concentration analysis from the same study (Fugro ERT, 2013).

The hydrocarbon analysis of the grab sample sediments from the 2011 survey (Section 5.1.1) indicated the samples were generally similar to each other, exhibiting a hydrocarbon distribution typical of low/mid-level weathered petroleum residues found in northern North Sea sediments (Fugro ERT, 2013).

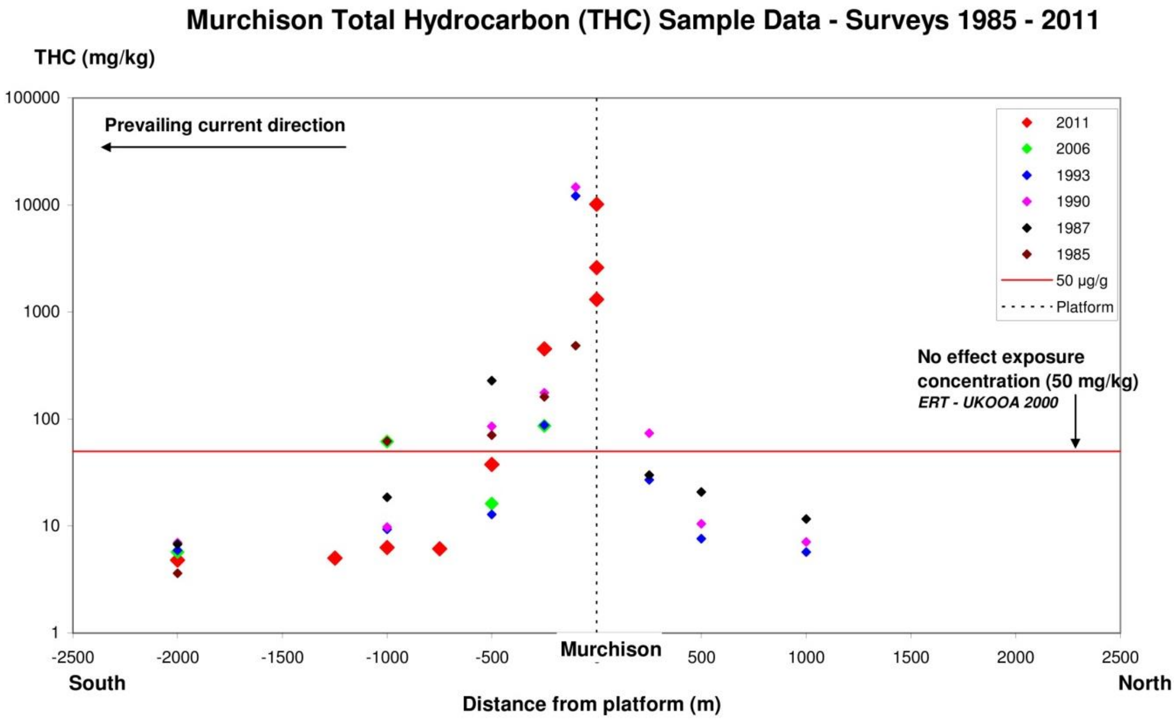


Figure 5.8: Historical sediment hydrocarbon concentrations at the Murchison Facilities area

Source: Fugro ERT (2013)

Table 5.4: Summary (mean levels) of sediment hydrocarbon analysis from the Murchison environmental seabed survey 2011

Distance of sampling station from wellhead centre (m)	THC (µg/g)	UCM (µg/g)	*n*-alkanes (µg/g)			CPI			Pristane (µg/g)	Phytane (µg/g)	Pr/Ph ratio	2 to 6 ring PAH
			$nC_{12\text{-}20}$	$nC_{21\text{-}36}$	$nC_{12\text{-}36}$	$nC_{12\text{-}20}$	$nC_{21\text{-}36}$	$nC_{12\text{-}36}$				
Drill cutting core 1	1,310	100	95.5	27.8	123	0.84	1.21	0.91	5.01	3.34	1.54	14.1
Drill cutting core 2	10,100	8,630	72.9	19.1	92.0	1.29	1.47	1.33	10.1	4.10	2.46	65.8
Drill cutting core 3	2,590	1610	417	26.9	444	0.88	0.69	0.87	2.91	1.41	2.07	14.8
0 (n=3)[1]	4,666.7	3,746.7	195.1	24.6	219.7	1.0	1.1	1.0	6.0	2.9	2.0	31.5
250 (n=1)[2]	450	402	6.16	4.67	10.8	0.9	1.1	1.0	0.7	0.5	1.3	2.4
250 (n=2)	38.0	33.2	0.6	0.8	1.4	0.9	1.3	1.2	0.06	0.05	1.4	0.3
500 (n=4)	16.4	14.3	0.9	0.4	0.6	0.9	1.3	1.2	0.02	0.02	1.4	0.1
750 (n=4)	5.8	5.0	0.04	0.2	0.2	1.0	1.6	1.4	0.01	0.005	1.9	0.06
1,000 (n=3)	5.0	4.4	0.04	0.2	0.2	1.0	1.6	1.5	0.005	0.002	2.9	0.08
1,250 (n=3)	4.5	3.9	0.03	0.2	0.2	1.0	1.6	1.5	0.004	0.001	2.2	0.05
2,000 (n=4)	4.8	4.1	0.02	0.2	0.2	1.1	1.7	1.6	0.003	0.001	3.0	0.05
5,000 (n=4)	4.9	4.2	0.02	0.2	0.2	1.1	1.6	1.5	0.004	0,001	3.8	0.05
10,000 (n=3)	4.3	3.7	0.02	0.2	0.2	1.2	1.8	1.7	0.006	0.001	7.3	0.05

Concentrations expressed as µg/g dry sediment

0 m = push core samples of pile cutting; 250-10,000 m = grab samples of sediment; [1] n=number of stations at each distance; [2] Station 4 (250 m at 170^{o})

Key:
- THC Total Hydrocarbon Concentration (sum of resolved/unresolved material from nC_{12} to nC_{36})
- UCM Unresolved Complex Material (concentration of unresolved material from nC_{12} to nC_{36})
- CPI Carbon Preference Index
- PAH Polynuclear Aromatic Hydrocarbons (total 2 to 6 ring PAH and alkylated species)

Source: Fugro ERT (2013)

Table 5.5: Summary (mean levels) of sediment PCB, APEs and organotin analysis and gross alpha/beta radionuclide levels in surface sediments from the Murchison environmental seabed survey 2011

Distance of sampling station from wellhead centre (m)	PCB: Total ICES / Dutch 7	Total APEs	MBT	DBT	TBT	Total Organotins	Gross Alpha*	Gross Beta*
0 (n=3)[1]	0.72	1062	0.4	2.4	2.9	5.5	502	498
250 (n=1)[2]	0.56	784	<0.4	1.0	1.5	2.5	240	530
250 (n=2)	0.12	14.7	<0.4	0.5	<0.4	0.4	280	366
500 (n=4)	0.10	9.0	<0.4	0.5	0.4	0.7	228	440
750 (n=4)	0.10	9.5	<0.4	0.4	<0.4	0.4	279	437
1000 (n=3)	0.10	5.7	<0.4	<0.4	<0.4	<0.4	234	430
1250 (n=3)	0.11	5.8	<0.4	<0.4	<0.4	<0.4	275	439
2000 (n=4)	0.12	2.5	<0.4	<0.4	<0.4	<0.4	289	398
5000 (n=4)	<0.1	4.0	<0.4	<0.4	<0.4	<0.4	253	408
10000 (n=3)	0.12	7.7	<0.4	0.4	<0.4	0.4	156	362

Concentrations expressed as ng/g dry sediment; *Concentrations expressed as Bq/kg dry sediment

0 m = push core samples of cuttings pile; 250-10,000 m = grab samples of sediment; [1] n=number of stations at each distance; [2] Station 4 (250 m at 170^{o})

Key: PCB polychlorinated biphenyls

APEs alkylphenols/ phenolethoxylates

MBT monobutyltin

DBT dibutyltin

TBT tributyltin

Source: Fugro ERT (2013)

Table 5.6: Summary (mean levels) of elemental concentrations in surface sediments from the Murchison environmental seabed survey 2011

Metal	Distance of sampling station from wellhead centre (m)									
	0 (n=3)[1]	250 (n=1)[2]	250 (n=2)	500 (n=4)	750 (n=4)	1,000 (n=3)	1,250 (n=3)	2,000 (n=4)	5,000 (n=4)	10,000 (n=3)
Al	15,226	10,700	2,865	2,935	2,507	2,653	2,733	2,697	2,527	1,686
As	19.40	22.50	4.33	5.72	5.01	5.50	5.59	5.55	4.51	1.70
Ba	295.00	1,845	1,756	862.50	317.50	182.80	191.03	177.25	73.15	59.27
TBa[3]	199,666	64,000	3,150	3,425	1,150	1,733	1,133	1187	817.50	650.00
Cd	3.01	1.58	0.07	0.06	0.03	0.05	0.04	0.05	0.06	0.04
Cr	39.60	65.30	14.35	12.10	9.24	8.67	9.36	9.54	12.14	6.91
Cu	131.17	146.00	21.55	11.30	5.00	3.40	3.25	2.87	2.53	2.45
Fe	32,743	25,100	10,525	10,422	8,752	8,910	9,410	9,242	7,375	4,056
Hg	2.83	2.33	0.03	0.19	0.13	0.15	0.37	0.21	0.15	0.05
Mn	647.67	278.00	102.20	91.35	81.08	81.40	86.27	82.03	82.48	43.27
Ni	33.43	25.20	5.24	4.64	3.94	3.99	4.02	4.29	6.54	3.07
Pb	1,453	447.00	22.45	17.93	11.01	8.28	8.27	7.10	5.44	3.11
Sr	968.33	535.00	233.50	345.00	266.25	344.33	307.00	362.50	393.25	94.27
V	40.27	61.20	16.50	17.00	14.98	15.60	17.33	16.35	12.65	6.27
Zn	628.67	628.00	229.50	84.23	25.80	17.43	16.07	13.15	10.23	6.46

Concentrations expressed as µg/g dry sediment

0 m = push core samples of cuttings pile; 250-10,000 m = grab samples of sediment; [1] n=number of stations at each distance; [2] Station 4 (250 m at 170°); [3] TBa is result for total barium by alkali fusion technique

Key: Al – aluminium; As – arsenic; Ba – barium; Cd – cadmium; Cr – chromium; Cu – copper; Fe – iron; Hg – mercury; Ni – nickel; Pb – lead; Sr – strontium; V – vanadium; Zn – zinc; Mn - Manganese

Source: Fugro ERT (2013)

Total Hydrocarbon Concentration

Overall distribution of the Total Hydrocarbon Concentrations (THCs) across the sampling stations in the Murchison Facilities area are shown in Figure 5.9. Total hydrocarbon levels in the wider Murchison Facilities area ranged from 1.0 µg/g at station 33 to 450 µg/g at station 4 (mean 24.8 µg/g), while those within the drill cuttings pile ranged between 1,310 µg/g to 10,100 µg/g (Fugro ERT, 2013). The values exceed the background concentrations quoted for THC in proximity to oil and gas installations (CEFAS, 2001a). A strong negative correlation (99.9%) exists between THC and distance from the platform (Table 5.4). Conversely, strong positive correlations were noted between THC, UCM, *n*-alkanes, aromatic hydrocarbons, nonylphenols, TBT and lead. Slightly lower (<99.0%) positive correlations were found to exist between THC, octylphenol, silt/clay content, total barium, radium-226 and the number of individuals (Fugro ERT, 2013).

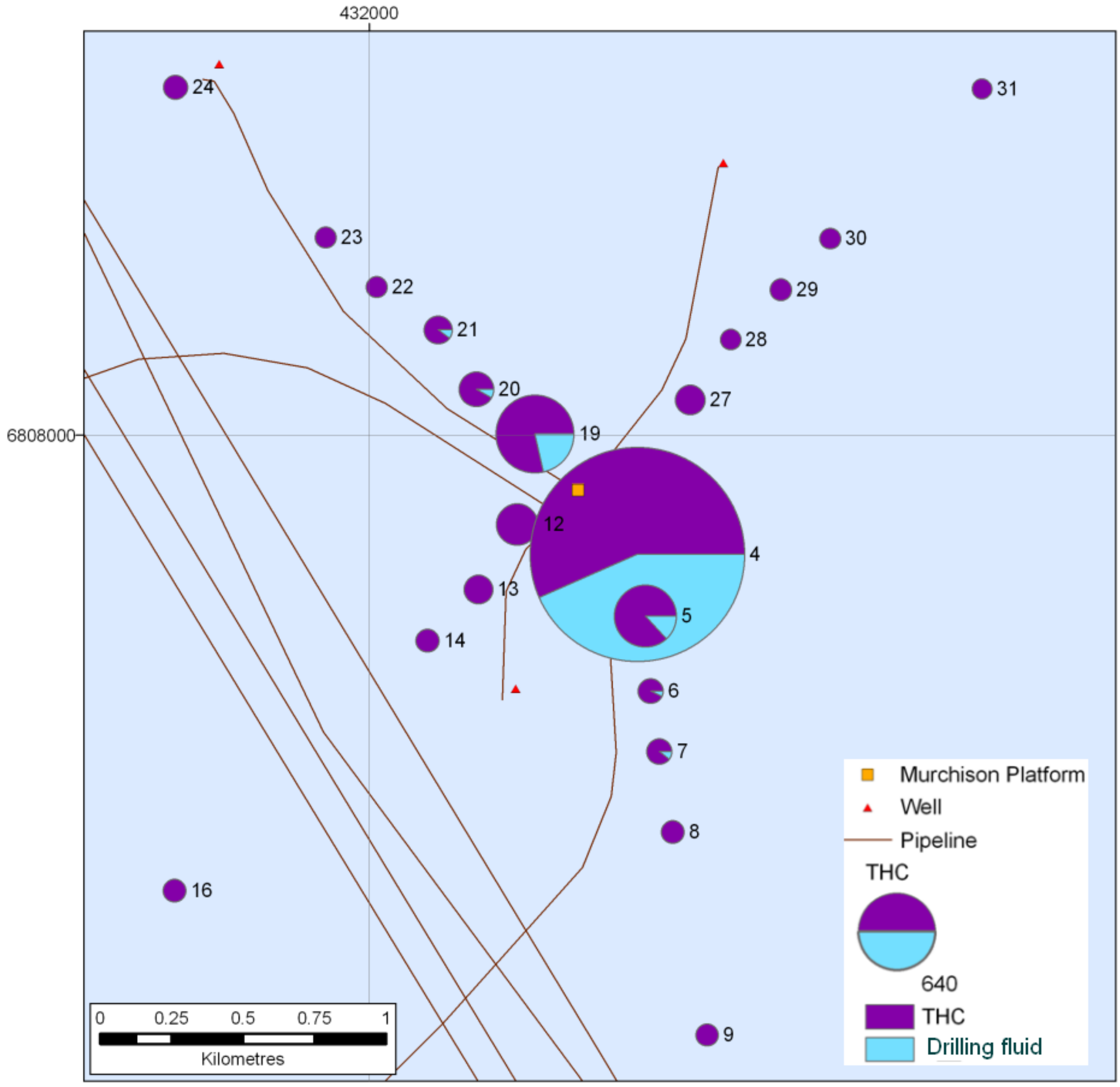


Figure 5.9: THC distribution across the Murchison Facilities area

Source: Fugro ERT (2013)

The UKOOA (2001) report summarising data from environmental surveys between 1975 and 1995, reports the mean THC (by gas chromatography [GC]) for stations greater than 5 km from platforms as 10.8 µg/g for the northern North Sea (UKOOA, 2001). The North Sea Quality Status Report (NSTF, 1993) suggests that typical THC levels (i.e. 'background') in sediments remote from anthropogenic activities range from 0.2 µg/g to 5 µg/g, although in some areas values may be as high as 15 µg/g (Fugro ERT, 2013). Table 5.4 suggests that the mean Murchison grab sample levels were higher than the cited background values up to 500 m from the platform; whereas levels beyond this distance were consistent with background levels. This outcome was skewed by the THC concentration from station 4. When the station 4 THC result was excluded the overall mean value for the grab samples returned was only 9.1 µg/g with a 95th percentile value of 24.2 µg/g.

Unresolved Complex Mixture

The Unresolved Complex Mixture (UCM) is composed of a mixture of hydrocarbons, which remain after substantial weathering and biodegradation of petrogenic inputs (Farrington *et al.,* 1977; Fugro ERT, 2013) and can provide an indication of the origin of contamination. The presence of the UCM in the Murchison Field (Table 5.4) suggests that there was a contribution to the sediments of weathered hydrocarbon material most likely originating from anthropogenic sources (Fugro ERT, 2013). The results for *n*-alkanes nC_{12} to nC_{36}, were typically dominated by the odd carbon numbered compounds nC_{29} and nC_{31} suggesting biogenic origin. However, there were exceptions with the samples within 500 m at 045º, 170º and 315º, where there was evidence of both diesel and linear paraffin type drilling fluid contamination in the sediments. Linear paraffin type base fluids, such as enhanced mineral oil based fluids (EMBF) or low toxicity oil based fluids (LTOBF), typically consist of the *n*-alkanes nC_{12} to nC_{15} although differing products may contain a wider range of *n*-alkanes (Fugro ERT, 2013).

Carbon Preference Index

The ratio of odd to even carbon numbered normal alkanes is termed the Carbon Preference Index (CPI) and was calculated over various chain length ranges (Table 5.4). The lower CPI ($nC_{12\text{-}20}$) values calculated (0.85 to 1.32; mean 1.03) corroborate the presence of the low-level chronic input of non-drilling related petroleum hydrocarbons in the wider background area sediments as well as the drilling fluid contamination at stations closer to the platform (Fugro ERT, 2013). The results from the drill cutting core samples were comparable with those derived for the wider Murchison area whereby the CPI values for ($nC_{12\text{–}36}$) ranged from 0.84 to 1.29 and the CPI (nC_{27} to nC_{31}) ranged from 0.91 to 1.33 (Fugro ERT, 2013) and did not show considerable increase.

Pristane/Phytane ratio

The isoprenoidal alkanes pristane (Pr) and phytane (Ph) were found in all of the sediment samples analysed (Table 5.4). The ratio of these compounds is used as an indicator of the relative input of petroleum hydrocarbons where a value less than 1.0 for those ratios is generally accepted to indicate anthropogenic origin (Cripps, 1989). These compounds are typically found in significant amounts in crude oils, although may also be bio-synthesised. The Pr/Ph ratios measured in the grab sample sediments overall ranged from 1.3 to 15.4 (mean of 2.9) with those in the drill cuttings pile ranging between 1.5 to 2.46 (Table 5.4; Fugro ERT, 2013) being indicative of biogenic origin of contamination.

Polycyclic Aromatic Hydrocarbons

Monitoring aromatic hydrocarbon type and content is particularly important due to the toxic nature (mutagenic/carcinogenic) of several of Polycyclic Aromatic Hydrocarbons (PAHs) even at very low concentrations. Overall aromatic hydrocarbon levels / PAHs in grab sample sediments collected during the 2011 survey ranged from 0.028 µg/g to 2.41 µg/g (mean 0.162 µg/g) (Table 5.3) and 14.1 µg/g to 65.8 µg/g (mean of 31.5 µg/g) in the push core sediments from the drill cuttings pile. The correlation between 2 to 6 ring PAH and distance is weakly negative (95.0%) (Table 5.4). A strong positive correlation (>99%) exists between the 2 to 6 ring PAH and the other hydrocarbon variables measured (THC, UCM, *n*-alk), with a weaker (<99.0%) positive correlation also exists between the 2 to 6 ring PAH, the alkyl-phenols, TBT, sediment characteristics, selected metals and radium-226 (Fugro ERT, 2013).

The mean Murchison grab sediment (2 to 6 ring) PAH concentration level (0.16 µg/g) was lower than the cited background data (BC) of 0.30 µg/g referenced in the UKOOA (2001) report and 0.21 µg/g in the OSPAR (2009a) report, but higher once normalised to 2.5% TOC (1.08 µg/g). Unlike the result for THC, removing the station 4 value alone made little overall difference to the mean PAH level. The measured and normalised mean (2 to 6 ring) PAH levels for the Murchison grab stations were, however, lower than the ER-Low (ERL) total of 3.3 µg/g, a value that includes only 11 of the parent PAH compounds and unlike the BC, has not been normalised. The ERL value is defined as the lower tenth percentile of the data set of concentrations in sediments which were associated with biological effects. However, adverse effects on organisms are rarely observed when concentrations fall below the ERL value (Fugro ERT, 2013).

Endocrine Disruptors (ED) are exogenous substances or mixtures that alter function(s) of the endocrine system and consequently cause adverse health effects in an intact organism, or its progeny, or (sub) populations (WHO, 2002). For the purposes of this survey, the EDs studied were PCBs, APEs and the organotins, mono, di, tri-butyltins (MBT, DBT, TBT) (Fugro ERT, 2013; Table 5.5). The results are discussed in more detail in subsequent sections.

Polychlorinated Biphenyls

There are 209 possible Polychlorinated Biphenyls (PCBs), with varying degrees of toxicity. OSPAR environmental monitoring has concentrated on a set of seven PCB congeners (ICES/Dutch 7), which cover the range of toxicological properties of the group. Total PCB (ICES/Dutch 7) levels in grab sample sediments ranged overall from <0.10 ng/g to 0.56 ng/g (mean 0.11 ng/g) and 0.44 ng/g to 0.99 ng/g (mean 0.72 ng/g) in the push core sediments from the drill cuttings pile. The mean Murchison grab sediment (ICES7) PCB concentration level was lower than the cited Background Assessment Concentrations (BAC) (mean 0.46 ng/g) referenced in OSPAR (2009a), but higher once the grab samples had been normalised to 2.5% TOC (mean of 1.06 ng/g) as the BAC value has been. Removing station 4 from the dataset made little difference to the mean PCB level. The measured and normalised mean ICES7 PCB levels for the

Murchison grab stations were substantially lower than the ICES7 PCB ERL of 11.5 ng/g (OSPAR, 2009a). No correlations were found between PCBs and the other environmental/macrofaunal variables assessed (Fugro ERT, 2013).

Alkylphenol Ethoxylates

Alkylphenol Ethoxylates (APEs) are natural constituents of petroleum and are found in produced water discharges from offshore oil and gas installations. Three APEs (nonylphenol (NP), octylphenol (OP) and 2, 4, 6-tri-tert-butylphenol (2, 4, 6-TTBP)) are listed by OSPAR as chemicals for priority action, as they are toxic to marine organisms because they bioaccumulate and persist in the environment (OSPAR, 2009a). Total APE levels for the grab samples from Murchison Field ranged overall from 4.1 ng/g to 784 ng/g (mean 35.5 ng/g), while total APE levels for the push core sediments ranged overall from 574 ng/g to 1690 ng/g (mean 1060 ng/g). OSPAR (2009a) provides assessment criteria for many sediment chemical contaminants; however, no criteria have been established for APEs or their derivatives. But, in comparison to other areas for which data was available, the mean Murchison sediment octylphenol (0.2 ng/g) concentration levels were lower than the cited background levels for Irish Sea (2006) and Baltic Sea (2008) (OSPAR, 2009b,c), even when normalised to 2.5% TOC (mean of 2.0 ng/g). The mean Murchison sediment NP (15.6 ng/g) concentration levels were also lower than the cited background levels for the southern and central Baltic Sea (2003) (OSPAR, 2009b, c), but when normalised to 2.5% TOC, the NP concentration (mean 77.1 ng/g) was higher than that found at the southern Swedish 'background' Baltic Sea reference site, but substantially lower than levels at a known contaminated site in the central Baltic Sea (Fugro ERT, 2013).

Organotin compounds

Organotins are a group of compounds which includes MBT, DBT and TBT. Organotins are entirely man-made and as a result most organisms have developed little or no resistance/tolerance to them (OSPAR, 2005b). Total organotin (tri-, di-, monobutyltin) levels for the grab samples ranged overall from <0.4 ng/g at the majority of stations, to 2.5 ng/g at station 4 (overall mean <0.4 ng/g). Total organotin levels for the push core samples ranged from 2.9 ng/g to 8.6 ng/g (mean 5.5 ng/g) (Fugro ERT, 2013). In 2009, OSPAR reported a provisional Environmental Assessment Criteria (EAC) for TBT as 0.01 ng/g and in 2004 a provisional upper EAC limit of 0.15 ng/g was suggested. The mean TBT levels from the Murchison grab samples were 0.17 ng/g and 0.6 ng/g with the data normalised to 1% TOC, both of which are higher than the upper OSPAR provisional upper EAC values. Significant negative correlations (99.0%) were found between TBT and distance (Table 5.5) and carbonate content (Fugro ERT, 2013).

Radionuclides

There are a number of potential sources of radionuclides in the marine environment including NORM. Radionuclide discharges from the oil and gas industry are mainly NORM (although some artificial radionuclides are used as tracers) and are mainly due to produced water discharges. This water is discharged to the marine environment and usually contains radionuclides from the naturally occurring uranium and thorium series. The radionuclides reported from the offshore oil and gas industry are: ^{226}Ra, ^{228}Ra, ^{210}Pb. The data are converted into total alpha and total beta (excluding tritium) activity in order to be able to compare the magnitude with discharges from other sectors (OSPAR, 2009d). Gross alpha from the Murchison samples ranged overall from 79 Bq/kg to 661 Bq/kg (mean 248 Bq/kg), while gross beta values ranged overall from 274 Bq/kg to 848 Bq/kg (mean 417 Bq/kg). These results were typical of those observed in background sediments (e.g. Štrok, *et al.,* 2010). The increased gross alpha and beta values obtained for station 3 matched the higher ^{226}Ra activity observed by gamma analysis (Fugro ERT, 2013). Given the lack of true 'background' data on North Sea radionuclides, aside from the oil and gas operational discharges, the results from the cutting pile have been included in the data set for comparison. The mean Murchison gamma and gross alpha/beta radionuclide activities (273 and 425 Bq/kg, respectively) were lower than the EC exemption value of 500 Bq/kg, the level below which wastes can be disposed of unconditionally (EC, 2002). Of the radionuclides assessed in the 2011 survey only the ^{226}Ra values showed a correlation (weak negative) with distance. All other radionuclide correlations were positive, mainly weak, between selected metals and sediment characteristics. Stronger correlations existed between ^{226}Ra and the hydrocarbon variables. Of all the samples tested station 3 returned the highest radionuclide activity levels for alpha/beta and gamma radiation; however, even these results were within ranges that can be found naturally in marine sediments (Fugro ERT, 2013).

Heavy metals

Metals occur naturally in the marine environment and are widely distributed in both dissolved and sedimentary forms. Anthropogenic inputs of metals to the marine environment are primarily as components of industrial and municipal wastes. Industrial inputs include the UKCS oil and gas industry. Of particular relevance to the offshore oil and gas industry are drilling discharges which can contain substantial amounts of barium sulphate (barite) as a weighting agent (NRC, 1983). Barite also contains measurable concentrations of heavy metals as impurities, including cadmium, chromium, copper, lead, mercury and zinc (NRC, 1983).

Comparison of the overall mean levels for cadmium, lead and mercury (Cd, Hg, and Pb) analysed in the Murchison grab sediments (0.13 µg/g, 25.6 µg/g, and 0.4 µg/g, respectively) against their relevant assessment criteria (BC, BAC, ERL) revealed cadmium and lead were below their assigned ERL (1.2 µg/g and 47 µg/g, respectively). Mercury exceeded the ERL (0.15 µg/g) primarily due to the high level measured at station 4 (2.33 µg/g). All three metals substantially exceeded their respective BC values when normalised to 5% aluminium. Both cadmium and lead levels have decreased since the last survey in 2006 back to levels similar to those recorded in 1993. Conversely, mercury levels have increased since 1993 and 2006 (Fugro ERT, 2013). Overall, excluding station 4, the levels of all metals in these sediments were of no obvious environmental concern and generally could be considered to be at natural background concentrations. Total barium shared many significant positive similarities with the contaminants typically associated to drill cuttings, i.e. hydrocarbons and metals. Likewise a significant negative similarity exists with distance as sample stations move away from the cuttings pile (Table 5.6), with the total barium concentrations being greatest at stations closest to the platform on the main residual current (Fugro ERT, 2013).

5.3 Biological Environment

5.3.1 Plankton

The planktonic community is composed of a range of microscopic plants (phytoplankton) and animals (zooplankton) that drift with the oceanic currents. These organisms form the basis of marine ecosystem food chains and many species of larger animals such as fish, birds and cetaceans are dependent upon them. The distribution of plankton therefore directly influences the movement and distribution of other marine species. The distribution and abundance of plankton is heavily influenced by water depth, tidal mixing and thermal stratification within the water column (NSTF, 1993). The majority of the plankton occurs in the photic zone (the upper 20 m of the North Sea which receives enough light for photosynthesis to occur) (Johns and Reid, 2001). The majority of phytoplanktonic organisms are unicellular, such as diatoms and dinoflagellates, whereas zooplankton comprises a wide variety of multicellular herbivorous and carnivorous organisms. Typical zooplankton organisms are the copepods, arrow worms, krill, and jellyfish. Zooplankton also includes the larval stages of non-planktonic organisms such as fish, crabs and barnacles (Johns and Reid, 2001). The composition of the plankton community reflects environmental conditions such as salinity, temperature, water movements in the area and the presence of local benthic communities that have planktonic larval stages.

The planktonic community may be vulnerable to elevated concentrations of chemicals or hydrocarbons in seawater as a result of planned or accidental releases. However, it is generally considered to be less vulnerable than benthic communities to one-off incidents, as many species have the capacity to recover quickly due to the continual exchange of individuals with those in surrounding waters (NSTF, 1993). Changes in the distribution and abundance of planktonic communities could, however, result in secondary effects on organisms that depend on the plankton as a food source, including commercial fish species and marine mammals. It is also possible that pollutants ingested by plankton could be accumulated by them and bio-accumulate in higher trophic levels (Johns and Reid, 2001).

5.3.2 Benthic Fauna

An understanding of the composition of the seabed (benthic) faunal communities can facilitate the assessment of the impacts of a proposed oil and gas activity, such as the decommissioning of the Murchison Facilities.

Benthic fauna comprises species which live either within the seabed sediment (infauna) or on its surface (epifauna). Such species, which may be either sedentary or motile and may encompass a variety of feeding habits (e.g. filter-feeding, predatory or deposit-feeding), occupy a variety of different niches. Benthic fauna are also typically divided into categories, principally according to size. The largest are the megafauna and this group comprises animals, usually living on the seabed, which are large enough to be seen in bottom photographs and caught by trawl (i.e. brittle stars, sea urchins, sea cucumbers, sea spiders, sponges and corals). Macrofauna are defined as those animals larger than 500 µm. Meiofauna comprises the smaller interstitial animals (mainly nematode worms and harpacticoid copepods) with a lower size limit of between 45 µm and 62 µm (Kennedy and Jacoby, 1999).

Colonisation of sediments by different species is largely dependent on the type of sediment present and its characteristics. Both physical and biological factors are important in governing species abundance and distribution, including seabed depth, water movements, salinity, temperature and available oxygen. Infaunal species are particularly vulnerable to external influences, which alter the physical, chemical or biological community of the sediment. Such infaunal organisms are largely sedentary and are thus unable to avoid unfavourable conditions. Each species has its own response and degree of adaptability to changes in the physical and chemical environment. Consequently, the species composition and relative abundance in a particular location provides a reflection of the immediate environment, both current and historical (Clark, 1996).

Benthic fauna are susceptible to physical disturbance of the seabed, for example from fishing trawls, anchoring, pipeline trenching and rock-placement operations, or smothering from discharged cuttings (DTI, 2001). The effects of discharged cuttings on benthic fauna include physical smothering, the presence of potential toxins (heavy metals and hydrocarbons), and organic enrichment (BMT Cordah, 1998). The responses shown by benthic communities to cuttings discharges are the result of a combination of these effects. Directly below a development the impact is through smothering beneath the cuttings pile. Beyond this point, the effects of any toxins and organic enrichment become more evident, and the changes in the species composition, diversity and abundance of benthic communities may be attributed to one or all of these influences (BMT Cordah, 1998).

Accidental events such as major oil spills and blowouts can result in oil reaching the seabed offshore. Long-term effects reported from such accidents range from none detected (e.g. after the Ekofisk blowout in 1977) to chemical contamination and chronic effects, but no acute biological effects detectable (e.g. after the wreck of the Braer in 1993) (DTI, 2001). Various attempts have been made to describe the macrobenthic invertebrate communities in the North Sea, with the model of Künitzer *et al*. (1992) being the most widely accepted. The Murchison Facilities area can be classified into Künitzer *et al*. (1992) Category IIIb, which is fine sediment below 100 m depth in the northern North Sea. This deep-water infaunal assemblage was found to be characterised by the polychaetes *Minuspio cirrifera*, *Aricidea catherinae* and *Exogone verugera* and the bivalve mollusc *Thyasira* spp.; with high densities (2,863 $\pm$ 1,844 individuals per m^2) and species richness (51 $\pm$ 13 species) (Künitzer *et al*., 1992).

Nine pre- and post-operational environmental monitoring surveys have been carried out around the Murchison Facilities (Section 5.1.6). The most numerically dominant species identified in all surveys were polychaete worms. Macrofaunal samples taken during the 1979 to 1980 surveys found a community dominated by polychaetes such as *Amythasides macroglossus*, *Aonides paucibranchiata* and *Exogone* spp.; Nematoda; and bivalve molluscs such as *Limatula subauriculata* and *Thasari sarsi*, as expected for this area of the northern North Sea. The surveys carried out in 1985 and 1987 found an increase in opportunistic polychaete species such as capitellids and *Rhaphidrilus* spp. In 1990 and 1993, a high abundance of opportunistic species indicative of organic enrichment were found, including capitellids, cirratulids, *Raricirrus beryli* and *Paramphinome jeffreysii* (UK Benthos, 2004), as well as juveniles of the brittle star *Ophiura* spp which favour disturbed sediments.

The 2006 UK Government/Industry Environmental Monitoring Committee survey of the Murchison Field (Hartley Anderson Limited, 2007; Section 5.1.5) found that the macrofaunal composition was generally similar between sampling stations. The macrofaunal assemblage was found to be typical for the sediment type and water depth present in the northern North Sea. However, analysis revealed a modified faunal community at the sampling station closest to the platform (250 m), with a high abundance of opportunistic species including the polychaetes *Paramphinome jeffreysii*, *Raricirrus beryli*, cirratulids and capitellids, and the presence of *Thyasira sarsi*, a species associated with organically enriched sediments. Univariate analysis indicated moderately reduced diversity at this station in comparison with stations further from the platform. Multivariate statistical analysis clearly distinguished this station from the other stations. However, the magnitude of the modification of the faunal community was seen to be moderate, and diversity remained high at all sampling stations. A less pronounced modification of the faunal community was also revealed at the next closest sampling station 500 m from the platform (Hartley Anderson Limited, 2007).

The 1982 survey, which took place during the major drilling phase of the development wells, indicated the extent of the benthic macrofaunal disturbance was close to the platform at a distance of 100 m and 250 m. The results of the 1985 survey showed indications of some benthic recovery at these distances, approximately 16 months after the major cuttings disharges had ceased, due to decreased levels of contaminants; however, intermediate stations (500 m and 1,000 m) showed slight alterations caused by spreading out of the contaminants from the cuttings pile (IOE, 1986).

Following further discharges of contaminated drill cuttings since 1985, the recovery of the benthos, evident at the two stations closest to the platform (100 m and 250 m), had been reversed.

The survey carried out during 1987 showed that the fauna at 1,000 m had recovered from the initial ‘wave’ of contaminant spread; however, the 1990 data indicated a subtle effect at 1,000 m extending the zone of effect to between 1,000 m and 2,000 m from the platform, possibly as the contaminants spread out on a second ‘wave’ (IOE, 1988). A slight recovery was seen during the 1990 survey at the 100 m, 250 m and 500m stations compared to 1987 (IOE, 1991).

The largest area of benthic perturbation was recorded during surveys carried out in 1987, 1990 and 1993. A highly modified community was found at 500 m from the platform and the zone of impact was considered to extend to between 1,000 m and 2,000 m. It must also be noted however that during 1993 the severity of the effect within 250 m had been reduced since 1990 (ERT, 1994).

During the most recent survey (2011) a highly modified community is still recorded at 250 m from the platform and subtle differences in species composition were also recorded between 500 m and 2,000 m.

Pre-decommissioning survey

The 2011 survey and seabed sampling indicate that the sediments of the Murchison survey area comprised of Holocene sediments of mainly fine to medium sands. Video stills from all stations sampled across the survey areas, excluding station 33, show the seabed habitats to be relatively similar comprising of fine/medium sand. Sediments contained small areas of cobbles/boulders and small amounts of gravel and autochthonous carbonate debris, predominantly shells (e.g. station 31, Figure 5.10). Bioturbation and evidence of animal tracks and burrows appeared to be present at some stations (e.g. station 18, Figure 5.10); however this is difficult to ascertain from the photographs. The sediments of station 33 were noted to be slightly different and comprised rippled muddy sand and limited coarser surface sediments, and autochthonous carbonate debris was evident (Figure 5.10). No bioturbation, animal tracks and burrows were evident from the photograph at station 33 (Fugro ERT, 2013).

Observations from seabed video footage and stills showed that visible epifauna and mobile megafauna were generally sparse across the survey area but a greater concentration was observed on the cuttings pile (stations 1 to 3, Figure 5.11). Taxa encountered included *Paguridae spp.* (hermit crabs); *Ophiura* sp. (brittlestar); species of *Asteroidea* (starfish); *Echinocardium* sp. and *Spatangus* sp. (sea urchins); and tubes of sabellid polychaetes. On some boulders and within the cuttings pile, anemones (*Thenaria* spp.) were also evident. Fish, mostly species of gadoid and some flatfish (*Pleuronectiformes* spp.), were abundant around the platform but sparse across the rest of the survey area (Fugro ERT, 2013).

Although differences in the sediment type were observed, the majority of the survey area was recorded as the habitat offshore circalittoral sand with the predominant biotope being SS.SCS.OCS.GlapThyAmy (Connor *et al*., 2004), *Glycera lapidum*, *Thyasira* spp. and *Amythasides macroglossus* in offshore gravelly sand (EUNIS A5.151; http://eunis.eea.europa.eu/). These habitats consist of sands and gravel, stone or shell and occasionally a little silt (<5%) and may be characterised by the polychaetes *Glycera lapidum* and *Amythasides macroglossus* with the bivalve *Thyasira* spp. in particular *Thyasira succisa*. The small ear file clam *Limatula subauriculata* is often common in some examples of this biotope (Connor *et al*., 2004).

Within the cuttings pile a biotope of SS.SMU.OMu.CapThy.Odub (EUNIS A5.3741) was observed (Connor *et al*., 2004). In offshore areas around platforms the changes in the sediment due to cutting deposition and organic enrichment from drill cuttings often leads to the development of communities dominated by the pollution tolerant opportunist species such as the polychaetes *Capitella capitata* and *Ophryotrocha* spp. These species are generally found in extremely high abundances and accompanied by *Thyasira* spp., *Raricirrus beryli*, *Paramphinome jeffreysii* and *Chaetozone setosa* (Connor *et al*., 2004).

Although specimens of the cold-water, reef-building coral *Lophelia pertusa* were evident on parts of the Murchison Platform (Figure 5.11), no evidence of subtidal reefs, submarine structures or any other potential Annex I Habitats was found across the rest of the survey area (Section 5.1.3).

Macrofaunal samples were collected and analysed from a total of 28 stations that were sampled in triplicate along two transects bisecting the Murchison wellhead location (45/225° and 315/170°) (Figure 5.2) using a double van Veen grab. Three stations were also sampled from the cuttings pile beneath the platform using cores collected by ROV (for further sampling and analysis details see Fugro ERT, 2013).

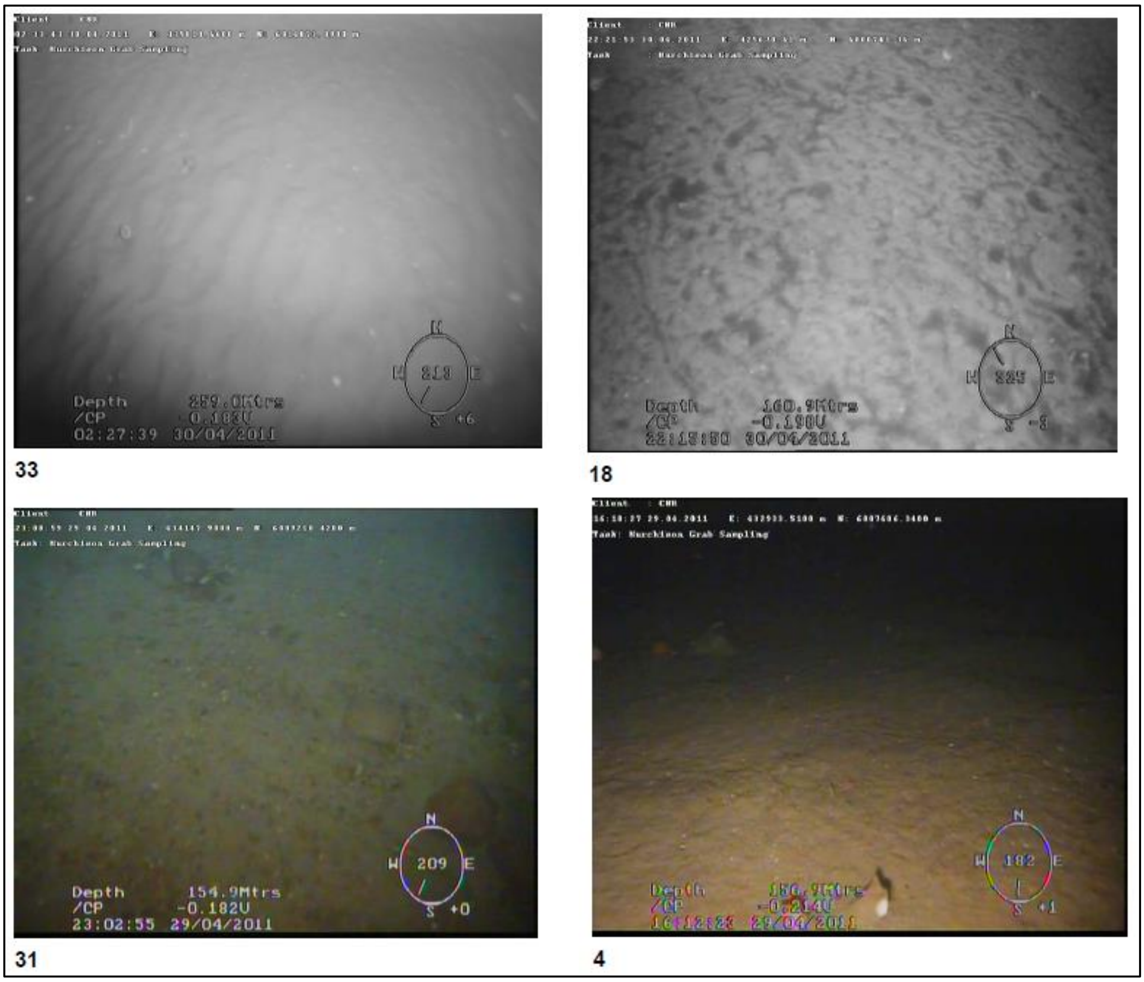


Figure 5.10: Video stills at grab sample stations 33 (10,000 m, 45° from platform), 18 (10,000 m, 225°), 31 (2,000 m, 45°) and 4 (250 m, 170°) during the Murchison environmental seabed survey 2011

Source: ISS (2011); Fugro ERT (2013)

Overall, approximately 48.5% of taxa were annelids, 24.7% arthropods, 19.1% molluscs, 3.7% echinoderms, and 4.0% other phyla (e.g. sipunculans, flatworms, cnidarians). The taxa and individuals across the Murchison survey area are broadly similar to those encountered previously in offshore sediments of this area (Eleftheriou and Basford, 1989; Oil and Gas, 2007 and 2010; and ERT, unpublished data).

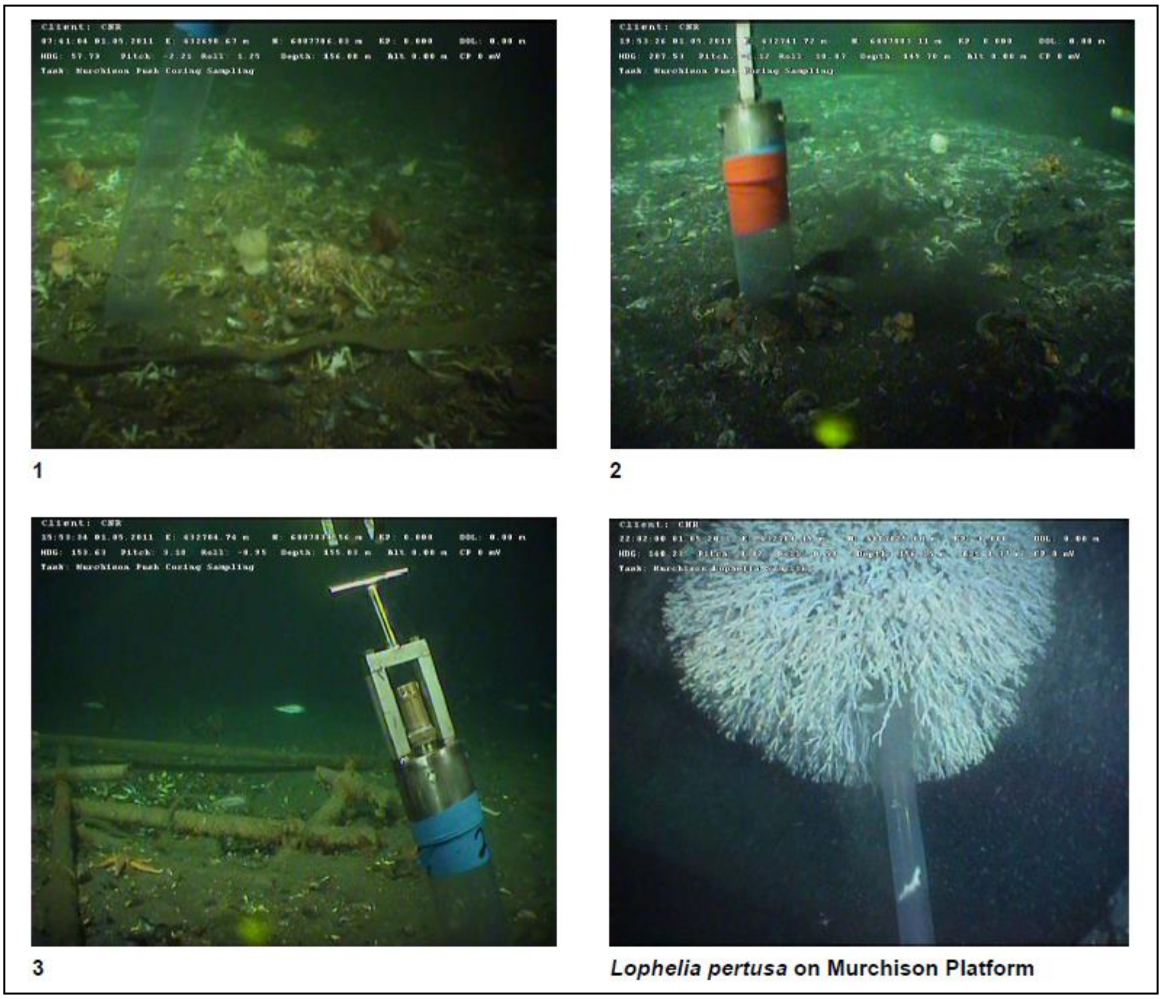


Figure 5.11: Video stills at core sample stations (1, 2 & 3) on drill cuttings pile and *Lophelia pertusa* on platform during Murchison environmental seabed survey 2011

Source: ISS (2011); Fugro ERT (2013)

The number of taxa, individuals and the diversity recorded at each grab station across the survey area ranged from moderate to high. The lowest number of individuals was found at the outer stations and numbers increased with decreasing distance from the platform location (Table 5.7).

Polychaetes were the most abundant group found both in number of taxa and individuals at all grab stations; however, no single taxon was dominant across the site. Common taxa included the polychaetes: *Galathowenia oculata*, *Spiophanes cf wigleyi*, *Aonides paucibranchiata*, *Amythasides macroglossus*, *Pteroeclysippe vanelli* and *Glycera lapidum*; and the molluscs *Timoclea ovata* and *Thyasiria* spp.

Table 5.7: Macrofaunal community statistics for grab sample stations (0.2 m^2) from the Murchison environmental seabed survey 2011

Station Number	Distance and Bearing		Numbers		Diversity Indices			Eveness	
	(m)	(°)	Taxa	Individuals	Simpsons (D)	Brillouins (Hb)	Shannon - Wiener (Hs)	Pielou (J)	Heip (Eh)
33	10,000	045	85	234	0.97	5.18	5.84	0.91	0.67
32	5,000	045	98	540	0.93	4.82	5.19	0.78	0.36
31	2,000	045	90	384	0.96	4.94	5.38	0.83	0.46
30	1,250	045	78	230	0.96	4.81	5.41	0.86	0.54
29	1,000	045	102	625	0.96	5.07	5.40	0.81	0.41
28	750	045	109	566	0.97	5.20	5.59	0.83	0.44
27	500	045	111	774	0.96	5.21	5.52	0.81	0.41
12	250	225	101	586	0.96	5.17	5.53	0.83	0.45
13	500	225	90	503	0.96	4.93	5.29	0.82	0.43
14	750	225	91	531	0.95	4.82	5.17	0.79	0.39
16	2,000	225	75	315	0.95	4.80	5.26	0.84	0.50
17	5,000	225	68	251	0.96	4.78	5.30	0.87	0.57
18	10,000	225	101	586	0.96	5.17	5.53	0.83	0.45
25	5,000	315	80	360	0.96	4.95	5.38	0.85	0.52
24	2,000	315	101	476	0.96	4.97	5.38	0.81	0.41
23	1,250	315	84	469	0.96	4.95	5.32	0.83	0.47
22	1,000	315	98	535	0.96	4.98	5.35	0.81	0.41
21	750	315	102	515	0.95	4.86	5.24	0.79	0.37
20	500	315	105	547	0.97	5.23	5.62	0.84	0.46
19	250	315	90	497	0.97	5.31	5.69	0.88	0.57
04	250	170	75	1285	0.80	3.40	3.53	0.57	0.14
05	500	170	109	802	0.96	5.25	5.55	0.82	0.42
06	750	170	88	513	0.95	4.90	5.25	0.81	0.43
07	1,000	170	87	501	0.96	4.98	5.34	0.83	0.46
08	1,250	170	90	464	0.96	4.89	5.27	0.81	0.42
09	2,000	170	82	413	0.96	4.93	5.33	0.84	0.48
10	5,000	170	76	311	0.94	4.62	5.08	0.81	0.44
11	10,000	170	61	137	0.97	4.68	5.44	0.92	0.71
Minimum			61	137	0.80	3.40	3.53	0.57	0.14
Maximum			111	1,285	0.97	5.31	5.84	0.92	0.71

Source: Fugro ERT (2013)

Univariate analysis and multivariate analysis highlighted variations within the benthic communities between the distance from the platform and the bearing of the grab stations. Grab stations closest to the platform contained highly modified benthic communities containing increased numbers of indicator species along with reduced numbers of hydrocarbon intolerant polychaetes. Communities between 500 m and up to 2,000 m on the residual current were found to have an increased number of taxa, individuals and diversity. Faunal assemblages were characterised by both high numbers of background species and increased numbers of mobile scavenger/predator carnivores which are sometimes associated with areas of higher PAH levels. The outer reference grab stations were shown to have both low numbers of taxa and individuals and were characterised by the polychaetes *Aricidea wassi*, *Spiophanes kroyeri*, *Tharyx killariensis* and *Aonides paucibranchiata;* and the crustaceans *Urothoe elegans*, *Harpinia antennaria* and *Tmetonyx cicada*. Correlation of the environmental variables against the community structure indicated that UCM, median diameter, silt, carbonate, arsenic and total barium were the main environmental variables influencing the benthic communities (Fugro ERT, 2013).

Overall, the environmental data obtained from the April/May 2011 environmental baseline survey at the Murchison site indicated that seabed sediments beyond approximately 500 m could generally be considered ‘as typical for this area of the northern North Sea region’.

5.3.3 Marine Growth

Over time, offshore platforms are likely to become colonised by marine fauna. Most offshore platforms are placed on soft-sediment bottoms which lack hard substrate and other features that would encourage the settlement and growth of flora and epifauna. Steel and concrete platforms therefore provide new attachment sites for marine life and, in effect, become artificial reefs. Algal spores and invertebrate larvae rapidly colonise submerged areas of the structures, establishing a ‘biofouling’ assemblage (Wolfson *et al*., 1979). The location of the platform and prevailing water currents affect the degree to which structures are exposed to these algal spores and invertebrate larvae. Consequently the composition and thickness of the fouling layer and its rate of development are affected by the site location and therefore may differ between offshore installations (AUMS, 1980). Unless protected by anti-fouling measures, any marine structure is liable to become fouled. Organisms that typically colonise platforms in the North Sea include seaweeds and kelp (algae), hydroids, soft corals, anemones, sponges, tubeworms, hard corals and mussels (AUMS, 1980).

A marine growth assessment carried out using ROV digital footage taken during a number of ROV surveys (2002 to 2009) of the Murchison jacket and conductors concluded that the Murchison jacket supported an extensive cover of marine growth (BMT Cordah, 2010). The general pattern of marine growth on the Murchison Platform as a function of depth is summarised in Table 5.8.

Table 5.8: Summary of the marine growth community composition on the Murchison Platform as a function of depth

Depth range (m, where 0 is the sea surface)	Pattern of marine growth
-6 to -20	Dominant organisms: seaweeds, hydroids and mussels; abundance generally decreasing with depth. Also present: tubeworms, barnacles, soft coral and anemones; abundance increased with depth.
-27 to -69	Dominant organisms: anemones and tubeworms; increasing abundance with depth. Also present: hydroids, soft coral, sponges and *Lophelia pertusa*; mussels and barnacles only present at -27 m.
-78 to -87	Dominant organisms: anemones, hydroids and tubeworms. The only other organism observed was *Lophelia pertusa*.

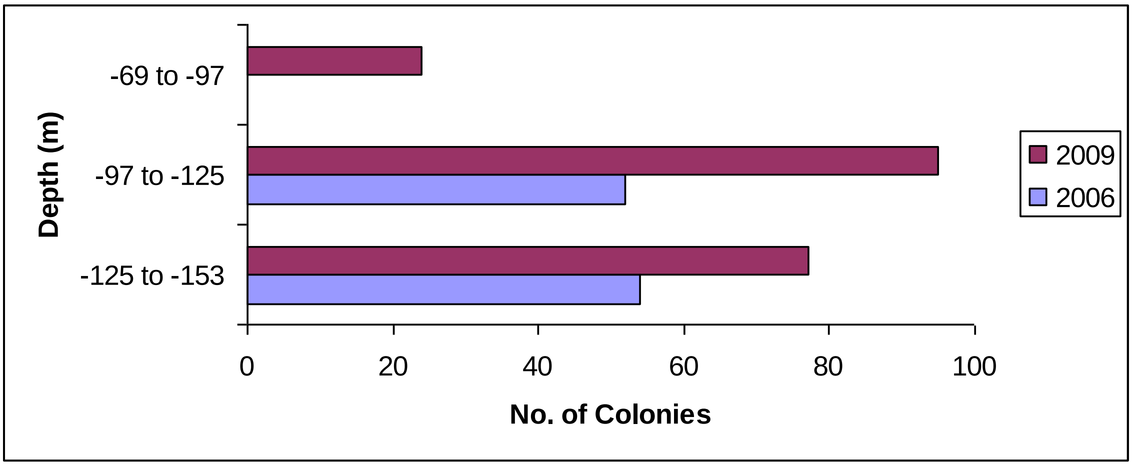
Source: BMT Cordah (2010)

From footage obtained in 2006 and 2009, the extent of *Lophelia pertusa* colonisation on the platform was found to be extensive, particularly at depths greater than 80 m. Individual colony thickness ranged from approximately 20 mm to in excess of 900 mm. The maximum average percentage cover was observed at depths of between 130 m and 140 m in 2006 (33%) and between 125 m and 130 m in 2009 (50%). The number of colonies, the percentage cover and the thickness of *Lophelia pertusa* on the Murchison Platform was found to have increased in all depth zones between 2006 and 2009 (Table 5.9; Figure 5.12; BMT Cordah 2010).

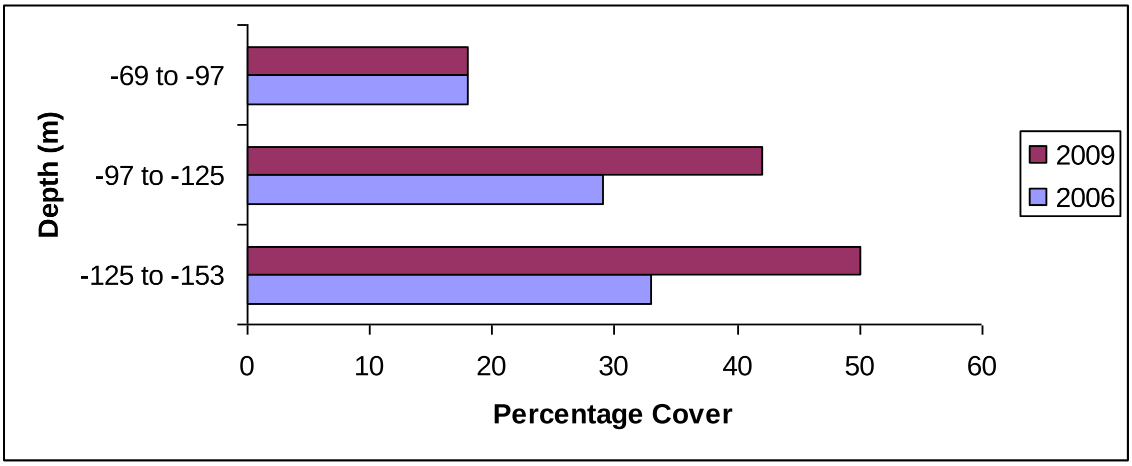
Table 5.9: Summary of average thickness and percentage cover of colonisation by the cold -water coral *Lophelia pertusa* with depth on the Murchison Platform in 2006 and 2009

Depth range (m)	Average *Lophelia pertusa* colonisation in 2006		Average *Lophelia pertusa* colonisation in 2009	
	Percentage cover	Thickness (mm)	Percentage cover	Thickness (mm)
-69 to -80	17	89	6	82
-80 to -90	15	214	15	276
-90 to -97	24	126	22	151
-97 to -100	20	224	37	354
-100 to -110	29	355	44	487
-110 to -120	24	346	47	522
-120 to -125	26	150	40	304
-125 to -130	21	235	50	423
-130 to -140	33	328	36	337

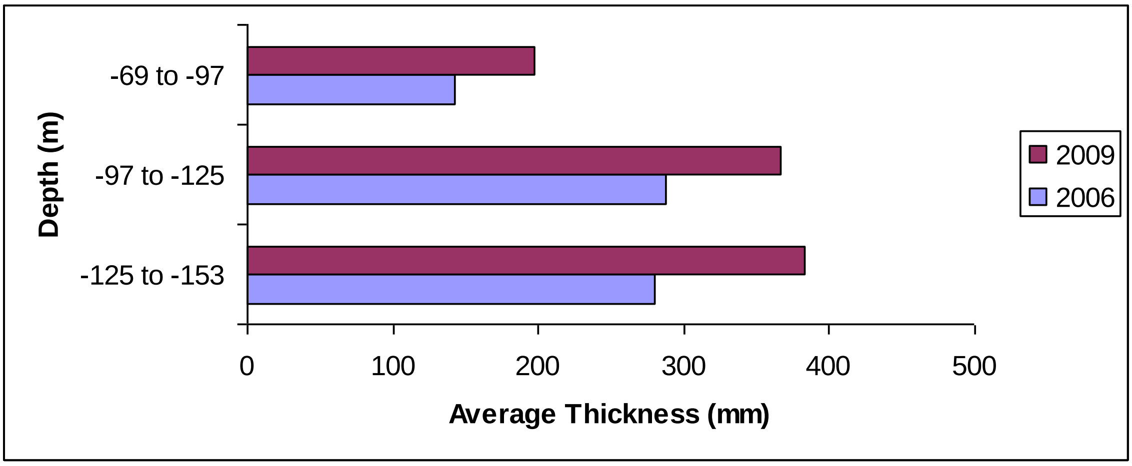
Source: BMT Cordah (2010)



a.) Average No. of *Lophelia pertusa* colonies



b.) Average percentage cover of *Lophelia pertusa*



c.) Average thickness of *Lophelia pertusa*

Figure 5.12: Comparison of colonisation of the cold-water coral *Lophelia pertusa* on the Murchison Platform in 2006 and 2009

Source: BMT Cordah (2010)

The overall composition of marine growth organisms and the pattern of marine growth on the Murchison Platform were found to have remained relatively unchanged in comparison to the marine growth recorded in 2002 and 2004 (BMT Cordah, 2010; BMT Cordah, 2004). Marine growth, including *Lophelia pertusa* colonisation, on the Murchison Platform was predicted to increase at all depths. It was also forecast that the dominant organisms would be likely to change (BMT Cordah, 2010).

A further ROV survey of the Murchison Platform (ISS, 2010) recorded large quantities of *Lophelia pertusa* on the platform conductors. ROV footage from that survey is shown in Figure 5.13.

Figure 5.13: Underwater ROV footage showing *Lophelia pertusa* growth on the Murchison Platform conductors

Source: ISS (2010)

5.3.4 Finfish and Shellfish

Adult and juvenile stocks of finfish and shellfish are an important food source for seabirds, marine mammals and other fish species. Species can be categorised into pelagic and demersal finfish and shellfish.

- **Pelagic** species occur in shoals swimming in mid-water, typically making extensive seasonal movements or migrations between sea areas. Examples of pelagic species include herring, mackerel, blue whiting and sprat.
- **Demersal** species live on or near the seabed and include cod, haddock, plaice, sandeel, sole, and whiting.
- **Shellfish** species are demersal (bottom-dwelling) molluscs, such as mussels and scallops, and crustaceans, such as shrimps, crabs and *Nephrops* (Norway lobster).

Generally, there is little interaction between fish species and offshore oil and gas developments. Some fish and shellfish species are, however, vulnerable to some offshore oil and gas activities, such as discharges to sea (CEFAS, 2001b). The most vulnerable period for fish species is during the egg and juvenile stages of their life cycles. Fish that lay their eggs on the sediment (e.g. herring and sandeels) or which live in intimate contact with sediments (e.g. sandeels and most shellfish) are susceptible to smothering by discharged solids (Coull *et al.*, 1998). 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' (JNCC, 2011).

'Safe biological limits' are defined by a minimum safe stock size and a maximum exploitation rate. The stock size is measured in terms of 'spawning stock biomass' (SSB), which represents the total weight of spawning fish each year. The exploitation rate is measured by 'fishing mortality' which represents the rate at which fish are removed from the stock by fishing. If the stock is either below the minimum safe SSB or above the maximum 'safe exploitation rate', the stock is said to be outside safe biological limits (Marine Scotland, 2011a). There have been a number of factors that have contributed to some fish stocks being outside 'safe biological limits' and these include a combination of overfishing, poor recruitment and poor fisheries management, with respect to underestimation of fish stocks and related issues (WWF, 2001).

Fish spawning and nursery locations in the vicinity of the Murchison Facilities area are shown in Figure 5.14 and Figure 5.15. These are based on data provided by the industry-commissioned Fisheries Sensitivity Maps in British Waters and DEFRA commissioned reports mapping the spawning and nursery grounds of selected fish species (Coull *et al*., 1998; Ellis *et al*., 2010). Figure 5.14 and Figure 5.15 relate to a generalised pattern of spawning; many species have much more tightly defined peak spawning areas. The information provided in Figure 5.14 and Figure 5.15 represents the widest known distribution given present knowledge and should not be seen as a fixed, unchanging description of presence or absence of a species (Coull *et al*., 1998; Ellis *et al*., 2010).

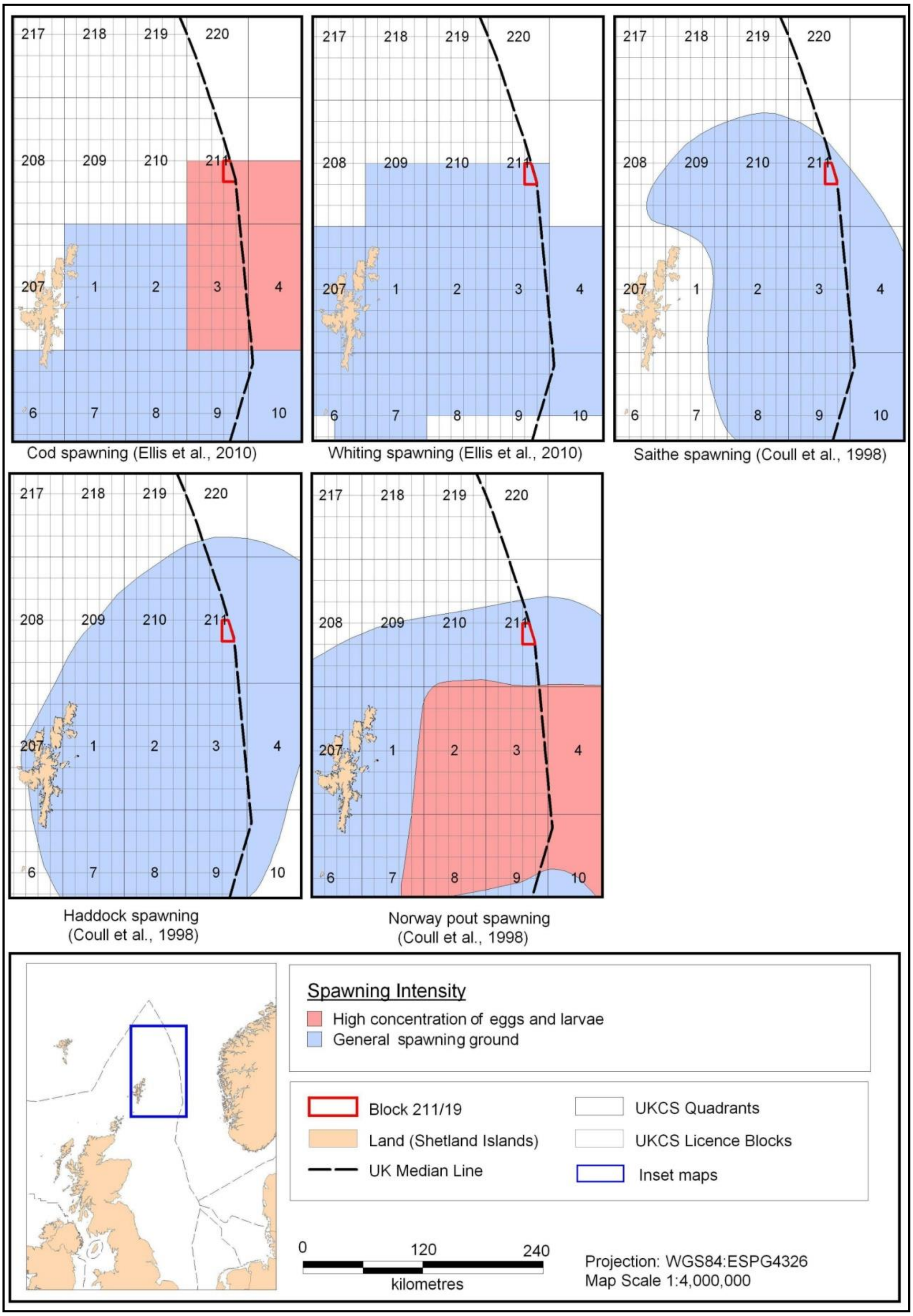


Figure 5.14: Key fish spawning areas around the Murchison Facilities area

Source: Coull *et al*. (1998); Ellis *et al*. (2010)

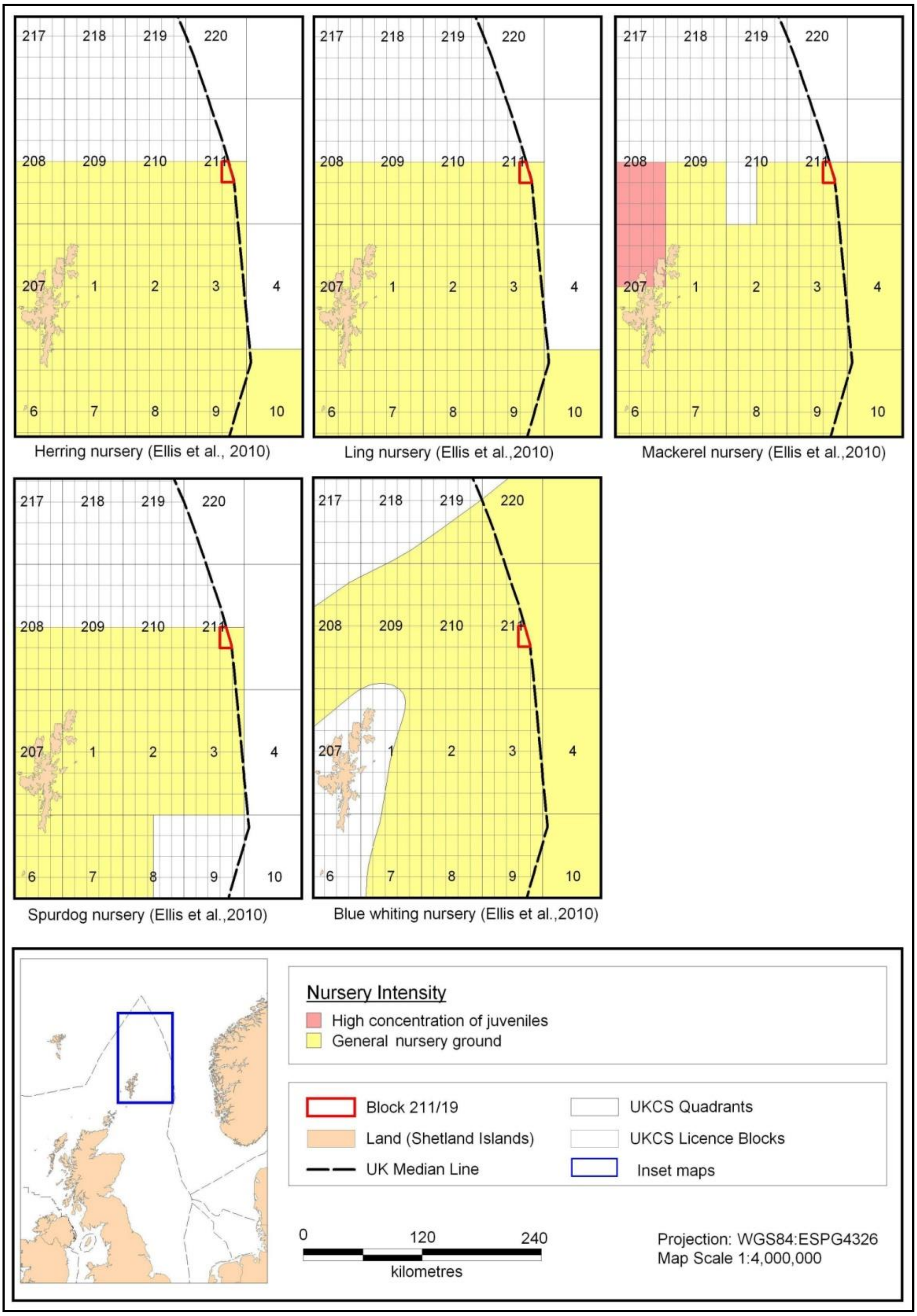


Figure 5.15: Key fish nursery areas around the Murchison Facilities area

Source: Coull *et al*. (1998); Ellis *et al*. (2010)

The Murchison Facilities lie within spawning grounds for cod (*Gadus morhua;* January to April), whiting (*Merlangius merlangus;* February to June), Norway pout (*Trisopterus esmarkii*; January to April), haddock (*Melanogrammus aeglefinus*; February to May) and saithe (*Pollachius virens*; January to April); and within nursery grounds for haddock, Norway pout, herring (*Clupea harengus*), ling (*Molva molva*), mackerel (*Scomber scombus*), spur dog (*Squalus acanthias*), and blue whiting (*Micromesistius poutassou*) (Table 5.10, Figure 5.14 and Figure 5.15).

Table 5.10: Spawning and nursery grounds in the vicinity of the Murchison Facilities

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Cod[1&2]	S	S*	S*	S								
Whiting[1&2]		S	S	S	S	S						
Norway pout[1]	S N	S* N	S* N	S N	N	N	N	N	N	N	N	N
Haddock[1]	N	S* N	S* N	S* N	S N	N	N	N	N	N	N	N
Saithe[1]	S*	S*	S	S								
Herring[2]	N	N	N	N	N	N	N	N	N	N	N	N
Ling[2]	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel[2]	N	N	N	N	N	N	N	N	N	N	N	N
Spur dog[2]	N	N	N	N	N	N	N	N	N	N	N	N
Blue whiting[1]	N	N	N	N	N	N	N	N	N	N	N	N

Key: *Period of intense spawning activity; S=spawning area; N=nursery area

Source: [1]Coull *et al*. (1998), [2]Ellis *et al*. (2010)

Cod occur throughout the northern and central areas of the North Sea and spawn all over the North Sea, although there are several areas where spawning is concentrated, including in the northern North Sea (CEFAS, 2001b). Cod spawning mainly takes place between January and April, peaking in February and March. At that time, the eggs are found floating near the water surface over large areas (CEFAS, 2001b).

Whiting is commonly found near the bottom in waters from 10 to 200 m deep, but may move into mid-water in the pursuit of its prey. Whiting spawning takes place February to June (Coull *et al*., 1998).

Norway pout are generally found in waters of 80 to 200 m over sandy and muddy substrates, but also occur in waters of up to 450 m depth, and are typically found in the northern and central areas of the North Sea. Peak spawning activity for Norway pout occurs during February and March and, though they have no specific nursery grounds, they are known to remain close to the spawning grounds in the northern North Sea (CEFAS, 2001b).

Haddock are generally regarded as benthic fish but they can also occur in mid-water. Peak spawning activity for haddock occurs between mid-March and early April (DTI, 2004), with the predominant spawning area between the Shetland Islands and the Norwegian Deep and south towards the Fladen ground (Knijin *et al*., 1993). The main spawning areas for saithe are east of the Shetland Islands and along the edge of the Norwegian Deep; spawning mainly occurs from January to March (CEFAS, 2001b; DTI, 2004).

Cod, whiting, Norway pout, haddock and saithe release their eggs into the water column to be fertilised. Their eggs and larvae remain planktonic after hatching until they mature and become demersal (CEFAS, 2001b). After spawning, fish hatch quickly from their eggs and many species remain in the water column as larvae, consuming microscopic organisms and gradually developing the body shape and behaviour patterns of adults. Juvenile fish can often be found in nursery areas together with slightly older individuals, and occasionally adults. Nursery grounds are used throughout the year, potentially making it impossible for an operation to avoid being coincident with the presence of juvenile fish.

5.3.5 Marine Mammals

Marine mammals include whales, dolphins and porpoises (cetaceans) and seals (pinnipeds). Marine mammals 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 and fish, can be of prime importance in determining the numbers and distribution of marine mammals and can also influence their reproductive success or failure. Changes in the availability of principal prey species may be expected to result in population level changes of marine mammals but it is currently not possible to predict the extent of any such changes (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.

Many whale and dolphin species can be found over a wide geographical range and no species is limited to UK waters. More than 20 cetacean species have been recorded in UK waters. Of these, nine species are known to occur regularly: minke whale (*Balaenoptera acutorostrata*), harbour porpoise (*Phocoena phocoena*), bottlenose dolphin (*Tursiops truncatus*), short-beaked common dolphin (*Delphius delphis*), white-beaked dolphin (*Lagenorhynchus albirostris*), white-sided dolphin (*Lagenorhynchus acutus*), killer whale (*Orcinus orca*), Risso's dolphin (*Grampus griseus*) and long-finned pilot whale (*Globicephala melas*) (Reid *et al*., 2003). Nine further species are infrequently recorded: striped dolphin (*Stenella coeruleoalba*), sperm whale (*Physeter macrocephalus*), pygmy sperm whale (*Kogia breviceps*), sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Cuvier's beaked whale (*Ziphius cavirostris*), Sowerby's beaked whale (*Mesoplodon bidens*) and the northern bottlenose whale (*Hyperoodon ampullatus*) (Reid *et al*., 2003; DECC, 2009b). These cetaceans are widely distributed in UK waters and are recorded throughout the year (Reid *et al*., 2003). Cetacean distribution may be influenced by variable natural factors such as water masses, fronts, eddies, upwellings, currents, water temperature, salinity and length of day. A major factor likely to influence cetacean distribution is the availability of prey, mainly fish, plankton and cephalopods (Stone, 1997).

The main marine mammal species occurring in the Murchison Facilities area are minke whale, long-finned pilot whale, killer whale, white-beaked dolphin, white-sided dolphin and harbour porpoise, with most sightings occurring in the summer months (Reid *et al*., 2003; UKDMAP, 1998). In addition, sperm whales have occasionally been sighted in the vicinity of Block 211 between May and October (UKDMAP, 1998).

Minke whales occur throughout the central and northern North Sea, particularly during summer months (DECC, 2009b; SMRU, 2001). Minke whales appear to move into the North Sea at the beginning of May and are present throughout the summer until October (Northridge *et al*., 1995). During the SCANS II survey in July 2005, minke whales were recorded throughout the North Sea, west of Britain and Ireland and on the Celtic Shelf. The highest densities of minke whales occurred in the northern part of the central North Sea (SCANS II, 2006). The number of minke whales in the SCANS II area is estimated to be approximately 17,500 animals (SCANS II, 2006; DECC, 2009b). The abundance of minke whales in the north and central North Sea is estimated at approximately 3,704 animals (SCANS II, 2006; DECC, 2009b).

Around the UK, long-finned pilot whales occur mainly along the continental shelf slope, particularly around the 1,000 metre isobath (Hammond *et al*., 2008). Pilot whale abundance in the central and eastern North Atlantic was estimated at approximately 780,000 in 1989, but there are currently no estimates of pilot whale abundance in UK waters (DECC, 2009b).

Killer whales have a worldwide distribution and are widely distributed in the deep North Atlantic and in coastal waters of northern Europe, particularly around Iceland, the Faroe Islands and western Norway. In UK waters they are most common off northern and western Scotland and occur in all months of the year. Between Shetland and Norway, the species is regularly recorded from November to March (Reid *et al*., 2003). No overall population estimates exist for killer whales in the Northeast Atlantic or UK waters (DECC, 2009b).

White-beaked dolphins are distributed over the continental shelf, and in the North Sea they tend to be more numerous within about 200 n miles of the Scottish and north-eastern English coasts (Northridge *et al*., 1995). White-beaked dolphins are present year-round in the North Sea, with most sightings recorded between June and October (Reid *et al*., 2003). Initial estimates for the total abundance of white-beaked dolphins in the SCANS II survey area are approximately 25,000 animals (SCANS II, 2006; DECC, 2009b). The abundance of white-beaked dolphins in the north and central North Sea is estimated at approximately 9,443 animals (SCANS II, 2006; DECC, 2009b).

The Atlantic white-sided dolphin is primarily an offshore species, but has been recorded during a number of surveys in the North Sea, especially during summer months (Northridge *et al*., 1997; Reid *et al*., 2003). The species shares most of its range with the white-beaked dolphin, but in the eastern North Atlantic it has a mainly offshore distribution and is regularly sighted in the waters north and west of Shetland, with greatest numbers observed along the shelf break and over deeper waters further offshore (DECC, 2009b). Their presence in the North Sea is seasonal, with the majority of sightings recorded between July and September (DECC, 2009b).

The harbour porpoise is the most common cetacean in UK waters (DECC, 2009b). It is present throughout most of the North Sea throughout the year, with higher numbers occurring between May and October. Highest densities in summer are generally found north of 56°N, mostly in a north-south band between 1°E and 3°E (SMRU, 2001). The northern and central areas of the North Sea appear to be important areas for harbour porpoises, especially in summer (DECC, 2009b; SMRU, 2001). The harbour porpoise is generally described as a coastal species, but there have been numerous sightings in deep, offshore waters (Hammond *et al*., 2002; MacLeod *et al*., 2003; Northridge *et al*., 1995; Rogan and Berrow, 1996).

Sperm whales are widely distributed in deep waters to the north and west of Scotland. They have also been observed fairly regularly in the waters around Orkney and Shetland, with sightings and strandings reported in most months (Hammond *et al*. 2002). Estimates of sperm whale abundance in UK waters rely on those for offshore European waters, as derived from the summer 2007 CODA survey. Across the entire survey area, abundance was estimated as 2,091 (coefficient of variation = 0.34; 95% confidence interval = 1,077-4,057), with sightings widespread across the area. Abundance in the two strata overlapping UK waters (1 and 2) was estimated as 1,122 (DECC, 2009b).

Marine mammals reported in the vicinity of the Murchison Facilities are summarised in Table 5.11; sightings have predominantly occurred in the summer months (UKDMAP, 1998).

Table 5.11: Seasonal cetacean sightings around the Murchison Facilities

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minke whale					L							
Long-finned pilot whale								VH				
Killer whale					M	M		L				
White-beaked dolphin							L					
White-sided dolphin					L	L		VH				
Harbour porpoise		VH			L	L	VH	L	L			
Sperm whale					L	L	L	L	L	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)
	(green)	Sightings within Quadrant 211
	(blue)	Sightings within surrounding Quadrants

Source: UKDMAP, 1998

Pinnipeds

Two species of seal are resident in UK waters, the grey seal (*Halichoerus grypus*) and the harbour or common seal (*Phoca vitulina*), both occurring regularly over large parts of the North Sea (SMRU, 2001). Both species breed in the UK, with harbour seals pupping in June and July and grey seals pupping between October and December.

The harbour seal is one of the most widespread pinniped species and is found in all coastal waters around the North Sea. Animals around the UK belong to a European sub-species (*P. vitulina vitulina*), approximately 33% of the world population of this sub-species occurs in the UK (DECC, 2009b). Estimated numbers of harbour seals in the UK, derived from aerial survey counts of hauled out individuals during the moult between 1996 and 2006, have resulted in a minimum estimated UK population of approximately 28,000 animals. The vast majority (85%) of these seals are found in Scotland (DECC, 2009b). Pupping occurs on land from June to July, while the moult is centred around August and extends into September. Therefore, from June to September harbour seals are ashore more often than at other times of the year. Seals are widespread throughout coastal waters surrounding breeding colonies and haul-out sites. Their distribution at sea is constrained by the need to return periodically to land (DECC, 2009b).

Grey seals are found across the North Atlantic Ocean and in the Baltic Sea. Approximately half of the world population occurs in the northeast Atlantic (including Baltic Sea); with approximately 40% of these animals occurring in the UK. The best estimate of population size in UK waters is approximately 130,000 animals, with growth of around 2.5% per annum (DECC, 2009b). It is estimated that approximately 70,000 seals are associated with breeding colonies in the North Sea (SMRU, 2001) and over 90% of the UK population breeds in Scotland (DECC, 2009b). Most of the grey seal population will be on land for several weeks from October to December during the pupping and breeding season, and again in February and March during the annual moult. Densities at sea are likely to be lower during this period than at other times of the year. They also haul-out and rest throughout the year between foraging trips to sea (DECC, 2009b). Grey seal foraging movements are on two geographical scales: long and distant trips from one haul-out site to another; and local repeated trips to discrete offshore areas (DECC, 2009b).

Tracking of seals suggests they make feeding trips lasting 2 to 3 days, travelling less than 40 km from their haul-out sites and ultimately returning to the same haul-out site from which they departed (JNCC, 2002). Grey seals may spend more time further offshore than harbour seals. Grey and harbour seals are listed in Annex II of the Habitats Directive (Section 5.3.7).

The Murchison Facilities are 150 km from the nearest coastline. Though their coastal habitats could be impacted by an accidental release of oil, it is unlikely that significant numbers of grey and harbour seals would be found in the vicinity of the facilities.

5.3.6 Seabirds

Important numbers of several species of seabird breed on the North Sea coastal margin, and depend on the offshore North Sea for their food supply and, for much of the year, their habitat. Species commonly found in offshore waters North Sea waters are fulmar (*Fulmarus glacialis*), gannet (*Morus bassanus*), guillemot (*Uria aalge*), razorbill (*Alca torda*) and kittiwake (*Rissa tridactyla*); and herring (*Larus argentatus*), great black-backed (*Larus marinus*) and lesser black-backed (*Larus fuscus*) gulls (DTI, 2001). Other species which are recorded at lower levels include the pomarine skua (*Stercorarius pomarinus*), Arctic skua (*Stercorarius parasiticus*), black-headed gull (*Larus ridibundus*), common gull (*Larus canus*), common tern (*Sterna hirundo*), Arctic tern (*Sterna paradisaea*), little auk (*Alle alle*), and puffin (*Fratercula arctica*) (DTI, 2001).

Seabird species which breed regularly in the UK and around mainland North Sea coasts include the four species of petrel (fulmar, Manx shearwater (*Puffinus puffinus*), storm petrel (*Hydrobates pelagicus*) and Leach's petrel (*Oceanodroma leucorhoa*)), two species of cormorant (cormorant (*Phalacrocorax carbo*) and shag (*Phalacrocorax aristotelis*), gannet, and kittiwake), two species of skua (great skua (*Catharacta skua*) and Arctic skua), six species of gull (herring gull, common gull (*Larus canus*), black-headed gull (*Larus ridibundus*), lesser black-backed gull, great black-backed gull and and kittiwake), five species of tern (Sandwich tern (*Sterna sandvicensis*), roseate tern (*Sterna dougallii*), common tern, Arctic tern and little tern (*Sterna albifrons*)) and four species of auk (guillemot, razorbill, black guillemot (*Cepphus grylle*) and puffin) (DTI, 2001; DECC, 2009c). Each year over 7 million seabirds breed in the UK (DECC, 2009c).

In general, offshore areas of the North Sea contain peak numbers of seabirds following the breeding season and through winter, with birds tending to forage closer to coastal breeding colonies in spring and early summer (DTI, 2001). High densities of fulmar are present offshore from May to November; kittiwake from November to March, and Guillemot from July to October. Gannet are present at low densities all year round.

Birds are vulnerable to oiling from surface oil pollution, which can cause direct toxicity through ingestion, and hypothermia as a result of the birds' inability to waterproof their feathers. During the moulting season, certain species (e.g. guillemot, razorbill and puffin) become flightless and spend a large amount of time on the water surface, making them particularly vulnerable to surface oil pollution (DTI, 2001). However, seabirds are not normally affected by planned offshore oil and gas operations (DTI, 2001). Although locally important numbers of birds have been killed directly by oil spills, such spills have primarily been associated with the transportation of oil, and little or no direct mortality of seabirds has been attributed to exploration and production activities (DTI, 2004).

Seabird vulnerability to surface pollution varies throughout the year with peaks in late summer after breeding when the birds disperse into the North Sea, and during the winter months with the arrival of over-wintering birds. To assess the relative risk for different species, the Joint Nature Conservation Committee (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 account of the following four factors (Williams *et al*., 1994):

- the amount of time spent on the water;
- total biogeographic population;
- reliance on the marine environment; and

- potential rate of recovery.

The seasonal vulnerability of seabirds in the Murchison Facilities area derived from the JNCC block-specific vulnerability data (JNCC, 1999), is shown in Table 5.12.

Table 5.12: Seasonal seabird vulnerability to oil pollution around the Murchison Facilities

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	All
211/13	3	4	3	4	3		2	4	3	3	4	4	4
211/14	3	4	3	4	3		3	4	3	3	4	4	4
211/15	3	4	3	4	3		3	4	3	3	4	4	4
211/18	3	3	3	4	3	4	2	4	3	3	4	4	4
211/19	**3**	**4**	**3**	**4**	**3**	**4**	**2**	**4**	**3**	**3**	**4**	**4**	**4**
211/20	3	4	3	4	3	4	2	4	3	3	4	4	4
211/23	3	3	2	4	3	4	2	4	3	2	2	4	4
211/24	3	3	4	4	3	4	2	4	3	3	2	4	4
211/25	3	3	4	4	3	4	2	4	3	3	2	4	4

Key		
	1	Very High Seabird Vulnerability
	2	High Seabird Vulnerability
	3	Moderate Seabird Vulnerability
	4	Low Seabird Vulnerability
	N/D	No Data

Source: JNCC (1999)

The most sensitive times of year for birds in the Murchison Facilities area (Block 211/19 and surrounding blocks) are March, July, October and November when vulnerability to oil pollution is “high” in some of the area. Vulnerability ranges from “moderate” to “low” for the remainder of the year. The overall seabird vulnerability to surface pollution in the Murchison Facilities area is “low” (see Table 5.12).

5.3.7 Offshore Conservation Areas

The European Community (EC) Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Flora and Fauna (the Habitats Directive) and the EC Directive 79/409/EEC 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 Annexes I and II of the Directive respectively. Habitat types and species listed in Annexes I and II are those considered to be in most need of conservation at a European level (JNCC, 2002; JNCC, 2011).

The UK government, with guidance from the 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 Annexes I and II) to be designated as Special Areas of Conservation (SAC). These designations have not yet been finalised, but will be made to ensure that the biodiversity of the area is maintained through conservation of important, rare or threatened species and habitats of certain species.

SACs are sites that have been adopted by the EC and formally designated by the government of each country in whose territory the site lies. Sites of Community Importance (SCIs) are sites that have been adopted by the EC but not yet formally designated by the government of each country. Candidate SACs (cSACs) are sites that have been submitted to the EC, but not yet formally adopted. cSACs are considered in the same way as if they had already been classified or designated, and any activity likely to have a significant effect on a site has to be appropriately assessed. Possible SACs (pSACs) are sites that have been formally advised to the UK Government, but not yet submitted to the EC. Draft SACs (dSACs) are areas that have been formally advised to the UK government as suitable for selection as SACs, but have not been formally approved by the government as sites for public consultation. A site remains a cSAC until it has been formally designated as a SAC by the UK Government, following approval as a Site of Community Importance (SCI) by the European Commission (JNCC, 2011).

In relation to UK offshore waters, four habitats from Annex I and four species from Annex II of the Habitats Directive are currently under consideration for the identification of SACs in UK offshore waters (Table 5.13; JNCC, 2002; JNCC, 2011).

Table 5.13: 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 that 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 shape (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 • Submerged or partially submerged sea caves	• Grey seal (*Halichoerus grypus*) • Harbour or common seal (*Phoca vitulina*) • Bottlenose dolphin (*Tursiops truncatus*) • Harbour porpoise (*Phocoena phocoena*)

Source: JNCC (2002); JNCC (2011)

Currently in UK offshore waters there are no SACs, twelve cSACs, five SCIs, three pSACs and one dSAC (Table 5.14; JNCC, 2011). In addition, there is an ongoing process of SAC identification in UK offshore waters. The JNCC has identified areas where additional SACs may be sited, following further survey work or analysis of data gathered through surveys already conducted. These areas are termed Areas of Search (AoS). There are currently seven AoSs in UK offshore waters (JNCC, 2011).

Table 5.14: Annex I conservation areas in the vicinity of the Murchison Facilities

Name	Description	Location	Site Location	Area (km^2)	Status	Approx. distance to Murchison
Pobie Bank Reef	Reef	northern North Sea	60°31'23″N 0°17'34″W	1,011	pSAC	113 km
Braemar Pockmarks UK003057	Submarine structures made by leaking gas	northern North Sea	58°59.4' N, 1°28.8' E	5.18	cSAC/ SCI	267 km
Scanner Pockmark UK0030354	Shallow depression approx. 600 m by 300 m and 20 m deep	northern North Sea	58°16.8'N, 0°58.2'W	3.35	cSAC/ SCI	349 km

Note: 1. All possible (pSAC) and draft (dSAC) boundaries are subject to confirmation; therefore, the site centre location and area are provisional and give only a general indication of the pSACs/dSACs.
Source: JNCC (2007; 2011)

The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (Amended 2007) apply the Habitats Directive and Birds Directive in relation to oil and gas plans or projects wholly or partly on the UKCS and adjacent waters outside territorial waters. These regulations extend to the seaward limits of territorial waters (12 n miles offshore) (DECC, 2009a).

The Offshore Marine Conservation (Natural Habitats, & c.) (Amendment) Regulations 2009 transpose the Habitats Directive and Birds Directive in the marine offshore area, from 12 n miles to 200 n miles from the UK coast. Under these regulations it is an offence to deliberately disturb any species, that has a designated SAC or SCI, or 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 (i) the ability of any significant group of animals to survive, breed, rear or nurture their young; or (ii) 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*) (DEFRA, 2010; JNCC, 2011).

Annex I Habitats

There are no known Annex I habitats in the immediate vicinity (within a 50 km radius) of the Murchison Facilities (Table 5.14, Fugro ERT, 2013). There is no evidence to suggest that any 'sandbanks which are slightly covered by seawater all the time', 'submerged or partially submerged sea caves' or bedrock or stony reefs are present. Although the biogenic reef-forming cold-water coral *Lophelia pertusa* has been observed to have colonised the Murchison Platform (see Section 5.3.3), it would not have occurred without the presence of the platform and therefore would not be considered as constituting an Annex I habitat. Additionally, Block 211/19 is outside of any identified areas of pockmarks.

Annex II Species

Of the Annex II species listed in Table 5.13, the only species sighted within the Murchison area is the harbour porpoise. It is sighted in very high numbers in February and July and in low numbers in May, June, August and September (UKDMAP, 1998; see Section 5.3.5).

Although the UK currently has no proposed SACs for harbour porpoise, the UK Government is re-examining distribution data for this species in inshore and offshore waters, in an attempt to identify likely areas as SACs, taking into account:

- The continuous or regular presence of the species (subject to seasonal variations).
- Good population density (in relation to neighbouring areas).
- High ratio of young to adults during certain periods of the year (JNCC, 2002).

Marine (Scotland) Act 2010

The Marine (Scotland) Act (which applies to Scottish territorial waters only) introduces new powers relating to functions and activities in the Scottish marine area, including provisions concerning marine plans, licensing of marine activities, the protection of the area and its wildlife including seals, and regulation of sea fisheries. The Act comprises six key elements: the formation of Marine Scotland, a strategic marine planning system, a streamlined marine licensing system, improved marine nature conservation measures, improved measures for the protection of seals and improved enforcement measures (JNCC, 2011).

Scottish Marine Protection Areas (MPAs) are a new national designation under the Marine (Scotland) Act for inshore waters and the Marine and Coastal Access Act 2009 for offshore waters, where Scottish Ministers have executive devolution of authority for the designation of MPAs for the conservation of important marine biodiversity and geodiversity out to 200 n miles.

No MPAs have yet been designated under the Marine (Scotland) Act. However, oil and gas activities are generally exempt from the new marine licensing and planning requirements under the Marine (Scotland) Act as during the development of the Act it was recognised that the environmental licensing oil and gas industry is already provisioned under DECC.

5.4 Socioeconomic Environment

This section focuses on the broader socioeconomic considerations of the existing baseline in relation to the Murchison decommissioning activities. Consideration is given to the potential impact on the fishing (UK and non-UK fishing in the area) 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.

5.4.1 UK Commercial Fishing Industry

An assessment of the fishing industry in the Murchison area has been derived from International Council for the Exploration of the Seas (ICES) fisheries statistics, provided by 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 Murchison 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 n miles by 30 n miles. Data was obtained for ICES rectangles 51F1 and 52F1, which contains the Murchison Facilities. Statistical data from the ICES rectangles provide information on the UK fishing effort and live weight of demersal, pelagic and shellfish caught by all UK vessels between 2008 and 2010 (Marine Scotland, 2012, 2011b).

Data on the economic value of the fishing industry in this area have been produced based on UK catches and landings (Marine Scotland, 2011b). 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. demersal, 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 and there is therefore the potential for these gears to interact with structures left on 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 demersal fishing methods. Demersal trawling methods interact with the seabed, and may interact with existing infrastructure on the seabed and historical seabed anomalies created by oil and gas activities, including disturbance from subsea structures left *in situ* such as footings, pipelines, rock-placement or concrete mattresses left or buried in the sediment.

Fishing effort

Fishing effort can be used to quantify the value of landings and establish whether or not any changes in landings are due to alterations in effort or in value of the catch (SFF Services, 2012). Fishing effort in number of days for different gear types in ICES rectangles 51F1 and 52F1 over the period 2008 to 2010 is shown in Table 5.15. For rectangle 52F1 only 2008 and 2009 data was available; although fishing activity took place in rectangle 52F1 in 2010, it involved five or fewer vessels and a breakdown of this fishing activity could therefore not be supplied for reasons of confidentially.

The total number of days' effort in 51F1 remained roughly constant between 2008 and 2009 at around 230 days each year with lower effort seen in 2010 and 2011 with only around 138 days and 87 days respectively. In 2008 and 2009, fishing effort was lower in 52F1 than in 51F1. The fishing effort in both rectangles was dominated by the demersal methods, bottom otter trawling and bottom pair trawls, accounting for 70% to 80% of the effort in 51F1 and around 50% of the effort in 52F1 (Tables 5.15a and 5.15b).The relative UK fishing effort in the Murchison area (ICES rectangles 51F1 and 52F1) in 2010 was "very low" in comparison with other areas of the North Sea.

The "relative effort" in ICES rectangle 51F1 was "low" for demersal fisheries and "very low" for pelagic. The "relative effort" in ICES rectangle 52F1 was "very low" for demersal fisheries and "very low" for pelagic. There was no recorded fishing effort for *Nephrops*, shellfish, industrial or other gears in either ICES rectangle (Table 5.16; Marine Scotland, 2011b).

Table 5.15a: UK fishing effort (days fished) according to gear type in ICES Rectangles 51F1 from 2008 to 2011

	Effort (days)			
	ICES Rectangle 51F1			
Gear Type	**2008**	**2009**	**2010**	**2011**
Otter trawls (not specified)	17.9	6.6	0.0	2.6
Otter trawls - bottom	94.4	118.9	79.8	66.4
Otter trawls - midwater	38.0	11.3	1.5	0
Otter twin trawls	12.3	26.1	14.7	14.7
Pair trawls – bottom	71.6	65.1	42.3	3.7
Pair trawls – midwater	3.0	1.5	0.0	0.0
Scottish seines	0.0	3.8	0.0	0.0
Set gillnets (anchored)	0.0	0.0	0.0	0.0
Total	**237.2**	**233.3**	**138.3**	**87.4**

Source: Marine Scotland (2012)

Table 5.15b: UK fishing effort (days fished) according to gear type in ICES Rectangles 52F1 from 2008 to 2011

	Effort (days)			
	ICES Rectangle 52F1			
Gear Type	**2008**	**2009**	**2010**	**2011**
Otter trawls (not specified)	8.5	2.4	No data	No data
Otter trawls - bottom	11.1	4.9	No data	No data
Otter trawls - midwater	0.0	1.5	No data	No data
Otter twin trawls	0.0	0.0	No data	No data
Pair trawls – bottom	2.1	0.0	No data	No data
Pair trawls – midwater	2.5	0.0	No data	No data
Scottish seines	0.0	0.0	No data	No data
Set gillnets (anchored)	1.3	1.2	No data	No data
Total	**25.5**	**10.0**	**-**	**-**

Source: Marine Scotland (2012)

Table 5.16: 'Relative Fishing Effort' of Commercial Fisheries in ICES Rectangles 51F1 and 52F1 for 2010

Effort	ICES rectangle 51F1	ICES rectangle 52F1
All species	"Very low" [<500 days]	"Very low" [<500 days]
Demersal	"Low" [100 – <300 days]	"Very low" [<100 days]
Pelagic	"Very low" [<30 days]	"Very low" [<30 days]
Nephrops	No data	No data
Shellfish	No data	No data
Other gears	No data	No data
Industrial gears	No data	No data

Source: Marine Scotland (2011b)

Catch composition

Between 2008 and 2010 the annual total live weight of fish landed from ICES rectangle 51F1 ranged from 490 tonnes in 2011 to 13,312 tonnes in 2008. The weight of fish landed from 52F1 ranged from 90 tonnes in 2011 to 1,009 tonnes in 2010 (Marine Scotland, 2012; Table 5.17).

Pelagic fish species dominated the catch (over 70%) in 2008, 2009 and 2010 in both rectangles, with demersal species dominating the catch (100 %) in 2011 (Table 5.17).

Table 5.17: Total landings (tonnes) of demersal, pelagic and shellfish species caught in ICES Rectangles 51F1 and 52F1 by UK and Foreign Vessels between 2008 and 2010

Species Type	Live weight (tonnes)							
	ICES Rectangle 51F1				ICES Rectangle 52F1			
	2008	2009	2010	2011	2008	2009	2010	2011
Demersal	905	622	452	489.5	230	151	43.5	90
Pelagic	12,405	2,626	583	0.1	543	533	965.4	0
Shellfish	2.0	1.3	1.8	0.7	0.1	0.1	No data	0
Total	**13,312**	**3,249.3**	**1,036.8**	**490.3**	**773.1**	**684.1**	**1,008.9**	**90**

Source: Marine Scotland (2012)

Figure 5.16 and Figure 5.17 show the catch composition of UK landings from UK and foreign vessels in ICES rectangle 51F1 and 52F1 for 2008 to 2010, respectively. Over this time period the catch was dominated by the pelagic species mackerel and the demersal species saithe in both rectangles. Mackerel made up 93% and 81% of the catch in 51F1 in 2008, and 2009 and 70% and 78% of the catch in 52F1 in 2008 and 2009. No pelagic species were landed in either ICES rectangle in 2010. Other species landed included cod, haddock, herring, monkfish (*Lophius piscatorius*) and whiting.

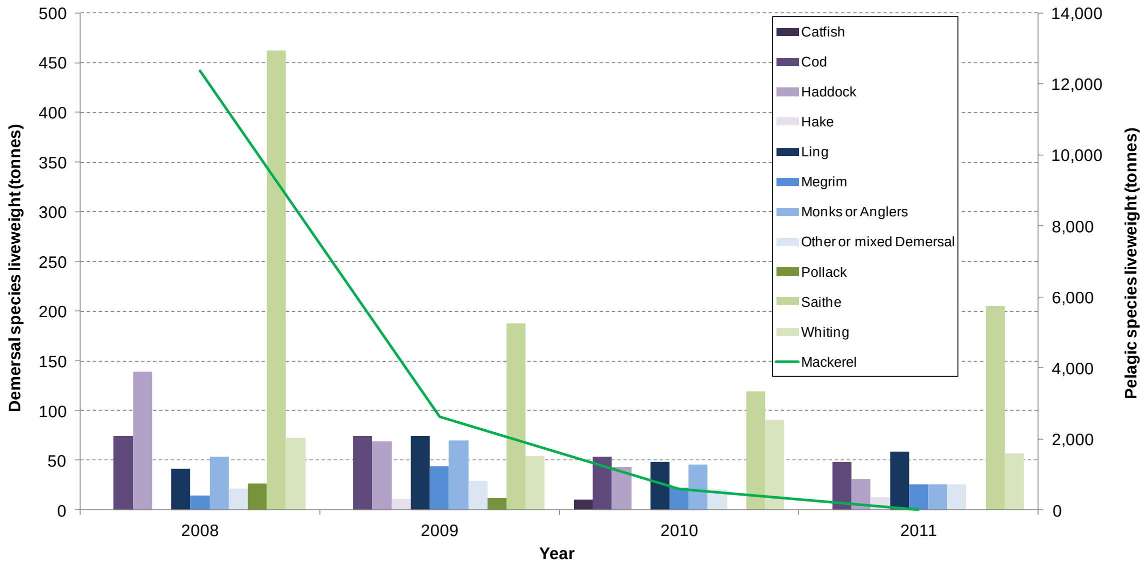


Figure 5.16: Catch Composition of UK Landings from UK and Foreign Vessels in ICES Rectangle 51F1 from 2008 to 2011

Source: Marine Scotland (2012)

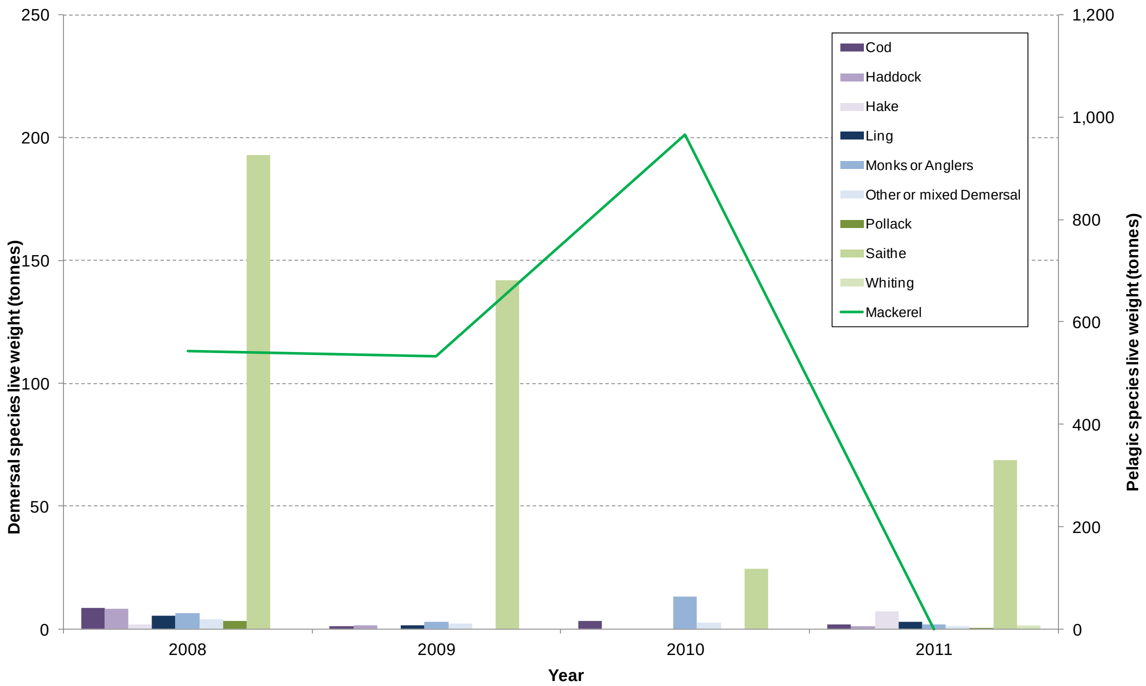


Figure 5.17: Catch Composition of UK Landings from UK and Foreign Vessels in ICES Rectangle 52F1 from 2008 to 2011

Source: Marine Scotland (2012)

Value

Marine Scotland (2011b) provide the "relative value" in 2010 of the demersal, pelagic, *Nephrops* and shrimps and shellfish fisheries, and for all species landed by UK vessels, for the Murchison Facilities area (ICES rectangles 51F1 and 52F1) as compared with all areas fished around the UK. The "relative value" gives an indication of sensitivity; damaging events, such as an oil spill, would be of more concern in an area of higher fisheries value than a similar spill in less productive waters.

In ICES rectangles 51F1 in 2010, the "relative value" was "low" for demersal fisheries, "very low" for pelagic, "very low" for *Nephrops* and shrimps and shellfish and "low" overall. The relative value was "very low" in ICES rectangle 52F1 for all fisheries (Table 5.18; Marine Scotland, 2011b).

Table 5.18: 'Relative Value' of Commercial Fisheries in ICES Rectangles 51F1 and 52F1 for 2010 (Murchison Facilities)

Value	ICES rectangle 51F1	ICES rectangle 52F1
All species	"Low" [> £0.5-1.5 million]	"Very Low" [<0.5 million]
Demersal	"Low" [>£0.5-£1.5 million]	"Very Low" [<£0.5 million]
Pelagic	"Very low" [<£1.5 million]	"Very Low" [<£1.5 million]
Nephrops and shrimps	"Very low" [<£0.5 million]	"Very low" [<£0.5 million]
Shellfish	"Very Low" [<£0.5million]	"Very Low" [<£0.5 million]

Source: Marine Scotland (2011b)

5.4.2 Non-UK Commercial Fishing Activity

It has been noted during discussions with stakeholders that the UK fisheries statistics will not represent the true levels of foreign vessel activity, as values are only recorded if foreign vessels land into a UK port. CNRI therefore commissioned SFF Services Ltd. to undertake a socioeconomic study which assesses the contribution of non-UK fishing vessels relative to the UK fishing activity in relation to the Murchison Facilities decommissioning activities. The study was part of an impact assessment of the potential interactions between Murchison decommissioning vessels and inventory to the existing fishing industry (SFF Services, 2012).

Fishing Effort

Fishing effort can be used to quantify the value of landings and establish whether or not any changes in landings are due to alterations in effort or in value of the catch (SFF Services, 2012). The highest effort recorded by non-UK vessels in the study area is by Irish, French and German registered vessels in the north of the regional study area, although considerably lower effort is recorded compared to UK registered vessels. All other non-UK vessels record lower effort (SFF Services, 2012).

On average, the recorded effort in days for the ICES 51F1 is 11 days for the period from 2001 to 2010. This is dominated by the use of pelagic mid water otter trawls and mid water pair trawls (Figure 5.18; SFF Services, 2012).

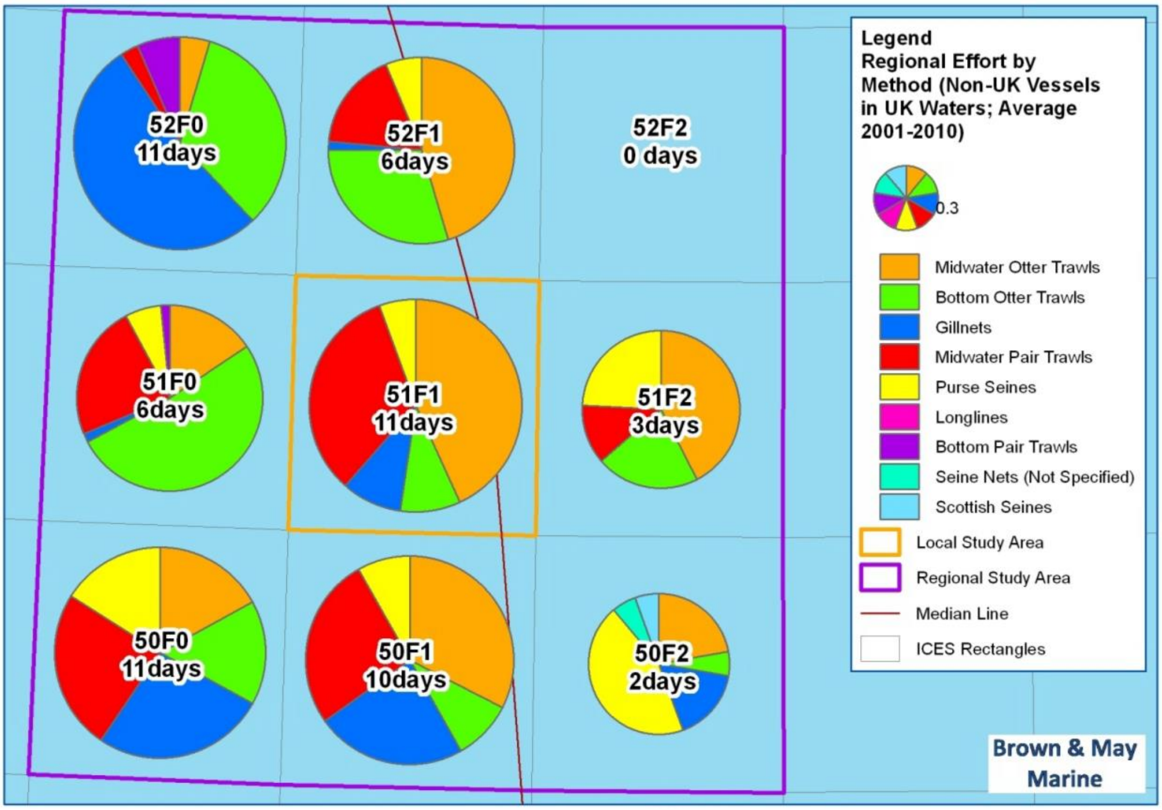


Figure 5.18: Effort by gear type for the non-UK vessels in the Murchison Facilities area

Source: SFF Services (2012)

Catch composition

Targeted by single and pair mid-water otter trawlers and purse seiners, mackerel contributes the most to landings values in the regional study area. Herring is also targeted by the non-UK pelagic fleet, but landings values for herring are recorded at much lower levels (Figure 5.19; SFF Services, 2012).

Value

An average annual landing overview of the fisheries activity by country is presented in Figure 5.20 (SFF Services, 2012). This broadly demonstrates the composition of the non-UK fleet active in the regional study area relative to Scottish, English and Northern Irish vessels which comprise the majority of the UK fleet. Approximately 23% of the total fishing boats in the 51F1 area for the period 2001 to 2010 were non-UK registered and were dominated by vessels from the Republic of Ireland and Denmark (Figure 5.19; SFF Services, 2012). Other foreign vessels in proximity to the Murchison Facilities were from Sweden, the Faeroe Islands, France and Norway (Figure 5.19; SFF Services, 2012).

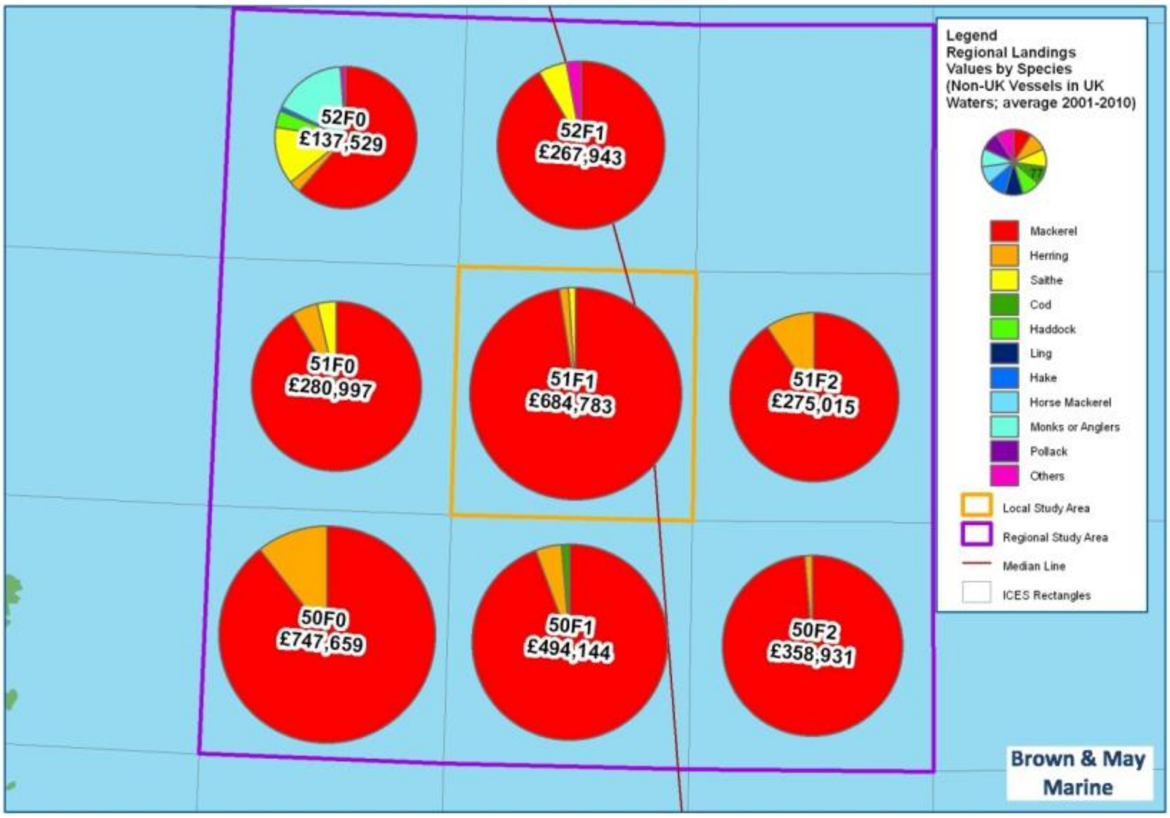


Figure 5.19: Annual landing value by species from non-UK vessels in the Murchison Facilities area

Source: SFF Services (2012)

The average overall value for the ICES 51F1 for the period 2001 to 2010 is £6,562,889 (SFF Services, 2012; Figure 5.20).

During the decommissioning project, there will be a potential for navigational conflicts arising between fishing vessels and decommissioning vessels transiting to and from the site. This could include vessels with towed gear being required to alter their towing direction, or fouling of fixed gear markers. This interference by decommissioning vessels has the potential to impact more fishing vessels than just those operating in the immediate vicinity of the Murchison Platform and its associated pipelines, depending upon the location of decommissioning port(s).

Detailed information about the presence of both UK and foreign fishing vessels in the Murchison Facilities area as well as the potential for interaction between the existing baseline fisheries activity and the decommissioning vessels and activities have been risk assessed (SFF Services, 2012) and the outcomes of this risk assessment are presented in Appendix B.

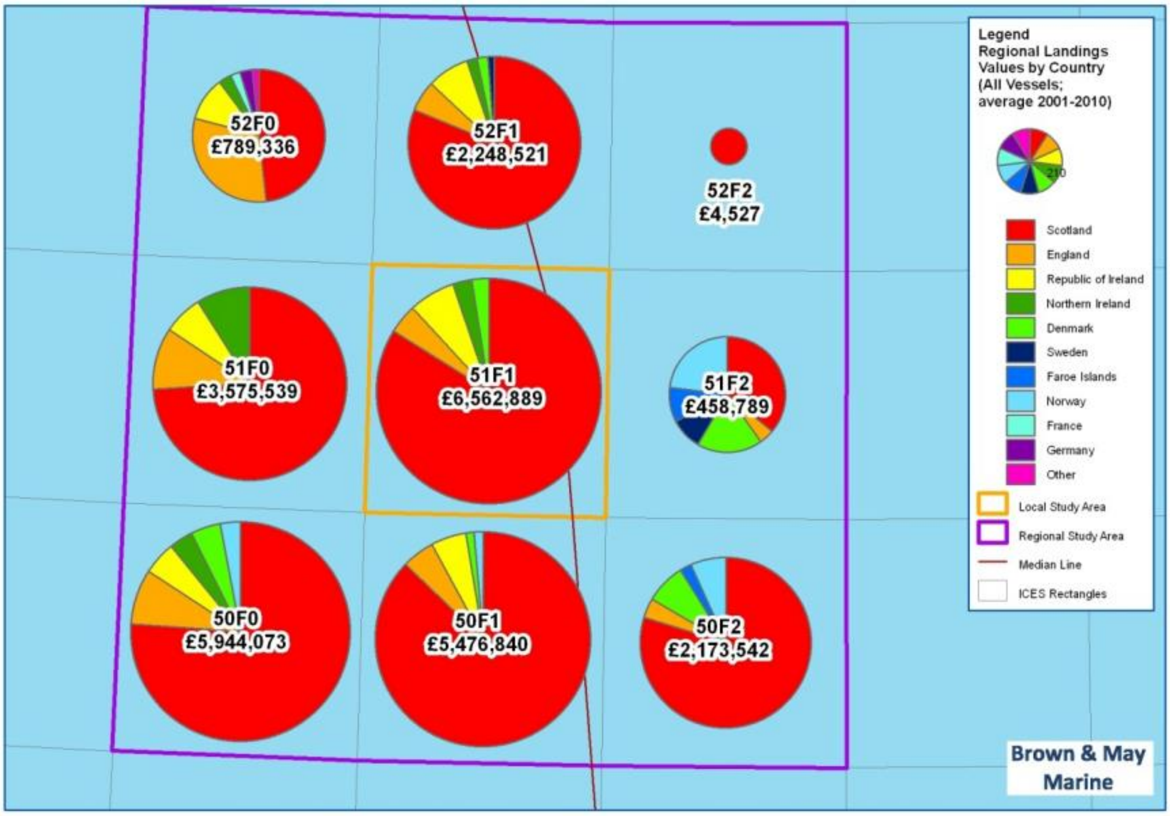


Figure 5.20: Average annual fishing landing of UK and non-UK vessels in the Murchison Facilities area

Source: SFF Services (2012)

5.4.3 Oil and Gas Industry

Oil and gas development in this region of the North Sea is relatively intensive. There are several oil fields (Table 5.19) and exisiting oil and gas infrastrucuture close to the Murchison Facilities, (Figure 5.21). An illustration of the existing oil and gas infrastructure in relation to Murchison is illustrated in Figure 5.21.

Table 5.19: Oil and gas field within close proximity of the Murchison Facilities

Field	Distance from Murchison	Direction from Murchison
Playfair	6 km	North
Thistle	8 km	West
Don	11 km	Northwest
Statfjord	15 km	Southeast
Penguin East	18 km	North

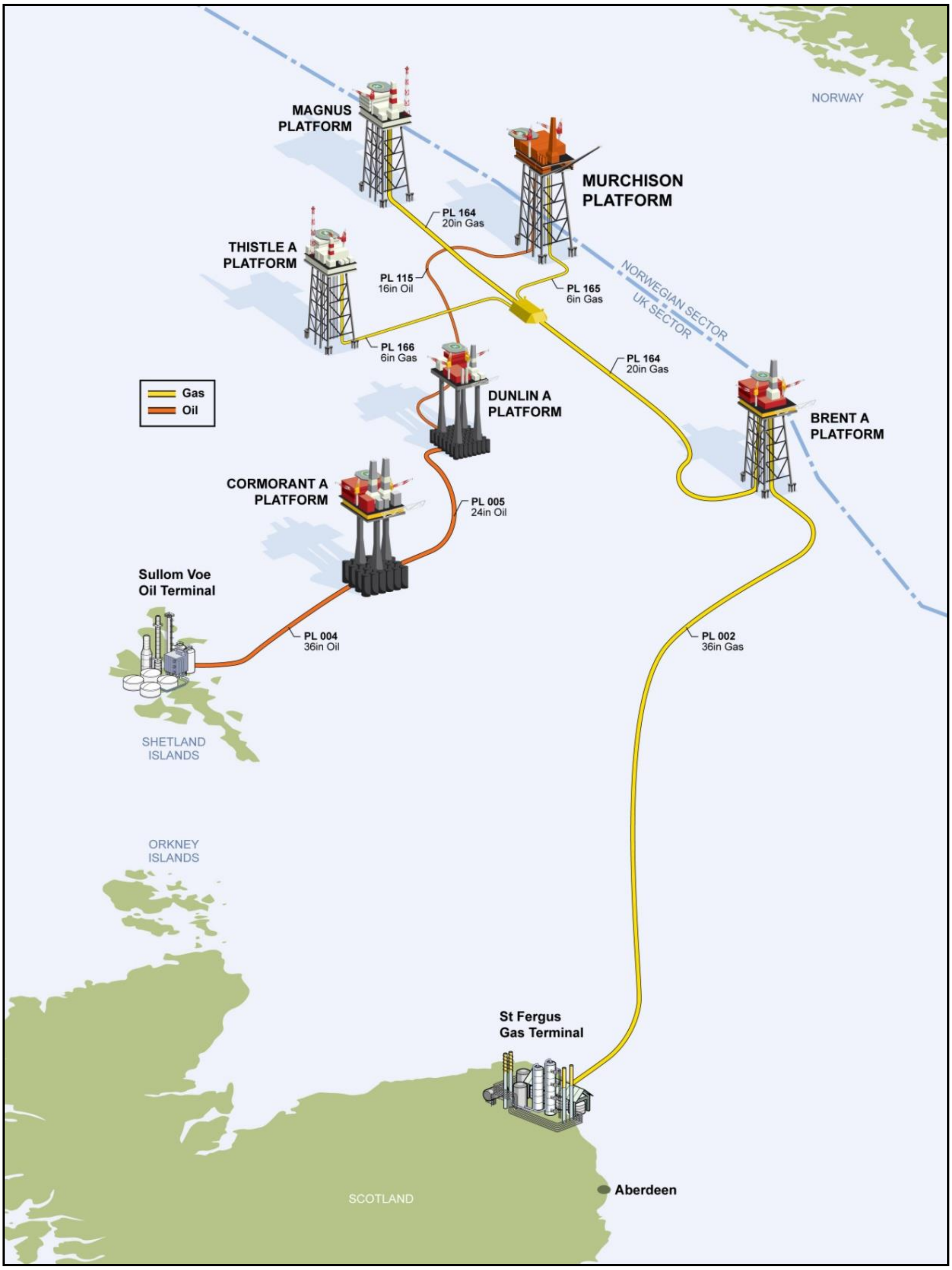


Figure 5.21: Existing oil and gas infrastructure close to the Murchison Facilities

Pipelines in the vicinity of the Murchison Facilities include the Brent 'C' SSIV to Penguins DC5 UCS – umbilical, Brent 'C' SSIV to Penguins - 16"/22" pipe-in-pipe oil pipeline and Brent 'C' to Penguins DC2 - 4" gas lift pipeline all operated by Shell, and the Magnus to Brent 'A' - 20" gas line (NLGP) operated by BP (CNRI, 2011b).

5.4.4 Shipping

CNRI commissioned Anatec to identify the shipping routes passing the Murchison Platform in the northern North Sea. Details of all shipping routes passing close to the Murchison Platform have been identified using Anatec's ShipRoutes database (Anatec, 2012; Table 5.20; Figure 5.22).

The Murchison Facilities are located in an area of low shipping activity (Anatec, 2012). There are 16 shipping routes that pass within 10 n miles of the Murchison Platform, with a total of 904 ships travelling through these shipping routes, which equates to an average of 2.5 vessels per day (Anatec, 2012). Shipping lanes are used by shuttle tankers, supply and standby vessels serving the offshore oil installations in the area.

Table 5.20: Ship Routes Passing within 10 n miles of the Murchison Platform

Route No.	Description	CPA (nm)	Bearing (°)	Ships Per Year	% of Total
1	Murchison-Thistle*	0.3	276	50	6%
2	Magnus-Murchison*	0.3	289	50	6%
3	Murchison-Ninian*	0.7	169	70	8%
4	Lerwick-Murchison*	0.7	223	52	6%
5	Aberdeen-Murchison*	0.8	179	40	4%
6	Kirkwall-N Norway/Russia	3.4	130	5	1%
7	N Norway/Russia-Lerwick	4.9	314	100	11%
8	Moray Firth-N Norway/Russia E*	5.3	125	25	3%
9	Aberdeen-Thistle ASCo EoS*	5.3	245	170	19%
10	Magnus-Thistle*	5.3	250	100	11%
11	Aberdeen-Don*	6.8	291	60	7%
12	Dunlin-Eider*	8.5	212	36	4%
13	Dunlin-North Cormorant*	8.9	212	24	3%
14	Statfjord Term.-Milford Haven SKOMER StB*	9.1	152	70	8%
15	Aberdeen-Dunlin*	9.1	209	26	3%
16	Dunlin-Lerwick*	9.1	209	26	3%
TOTAL				**904**	**100%**

Source: Anatec (2012)

* Where two or more routes have identical Closest Point of Approach (CPA) and bearing they have been grouped together. In this case, the description lists the sub-route with the most ships per year

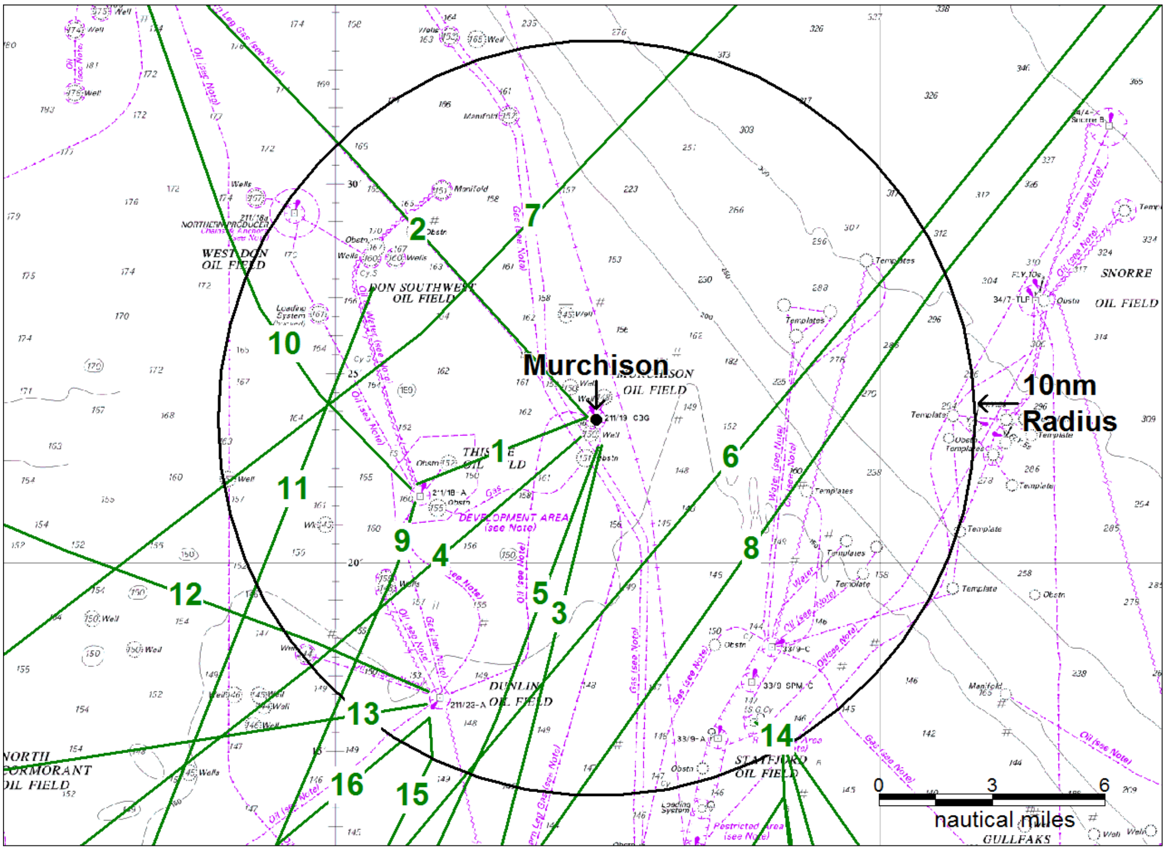


Figure 5.22: Shipping Route Positions within 10 n miles of the Murchison Platform

Source: Anatec (2012)

Routes 1 - 5 (Table 5.20) pass within 2 n miles of the Murchison Platform. Details of these routes are as follows:

- Route No. 1 is used by an estimated 50 vessels per year between Murchison and Thistle. This route passes the location to the west at a mean distance of 0.3 n miles.
- Route No. 2 is used by an estimated 50 vessels per year between Magnus and Murchison. This route passes the location to the west at a mean distance of 0.3 n miles.
- Route No. 3 is used by an estimated 70 vessels per year between Murchison and Ninian. This route passes the location to the south at a mean distance of 0.7 n miles.
- Route No. 4 is used by an estimated 52 vessels per year between Lerwick and Murchison. This route passes the location to the southwest at a mean distance of 0.7 n miles.
- Route No. 5 is used by an estimated 40 vessels per year between Aberdeen and Murchison. This route passes the location to the south at a mean distance of 0.8 n miles.

The remainder of the routes have mean positions of over 2 n miles from the Murchison location.

The main traffic lanes in the vicinity of the Murchison location, including the widths of the shipping routes and the shipping density passing through the area, have been estimated by creating a grid of cells with dimensions 1 n miles x 1 n miles and 10 n miles radius. A map showing the estimated variation in shipping density around the Murchison Platform (Figure 5.23) shows high annual shipping density from the south west, and medium to low density on the eastern side of the area (Anatec, 2012).

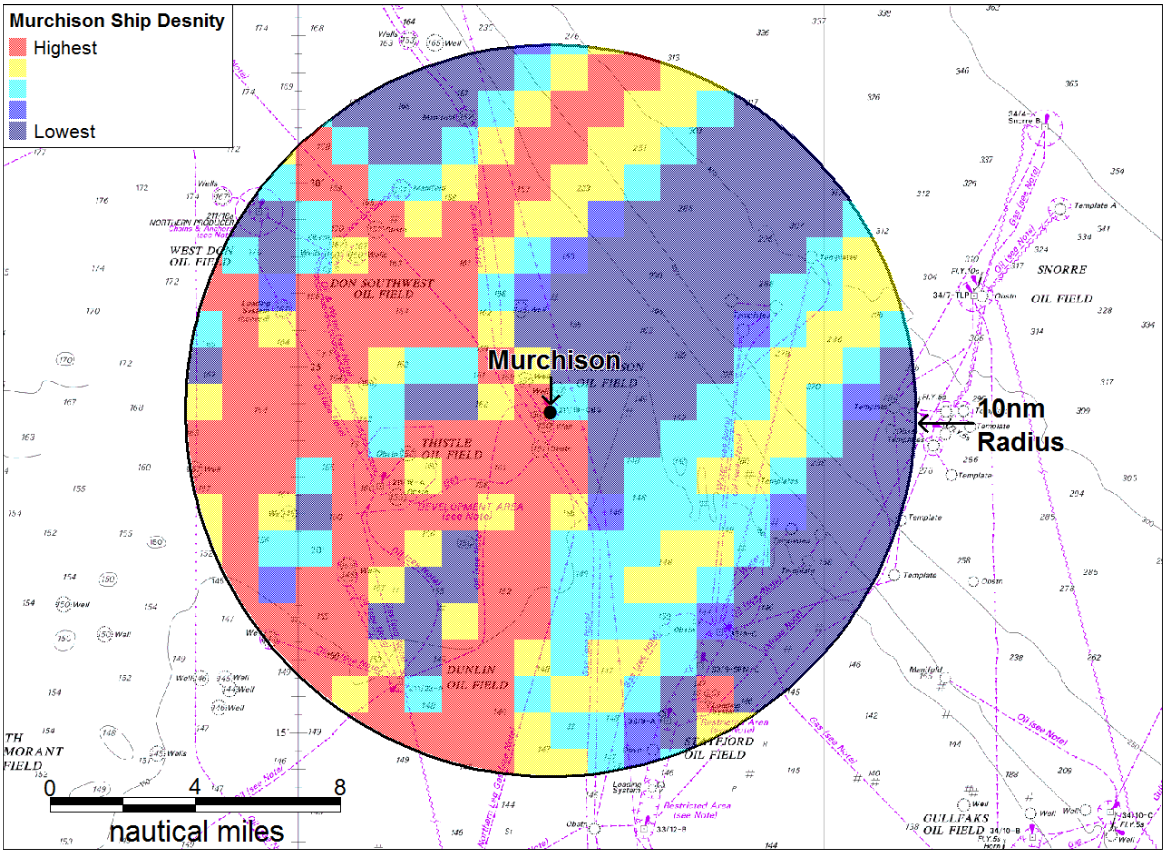


Figure 5.23: Shipping Density Grid within 10 n miles of the Murchison Platform

Source: Anatec (2012)

The dominant vessel type in the Murchison Field is offshore supply vessels (Figure 5.24) with sizes of 1,500 to 5,000 dead weight tonnage (DWT) (Figure 5.25). The rest of the shipping in the area is comprised of tanker and cargo vessels (Figure 5.24; Anatec, 2012).

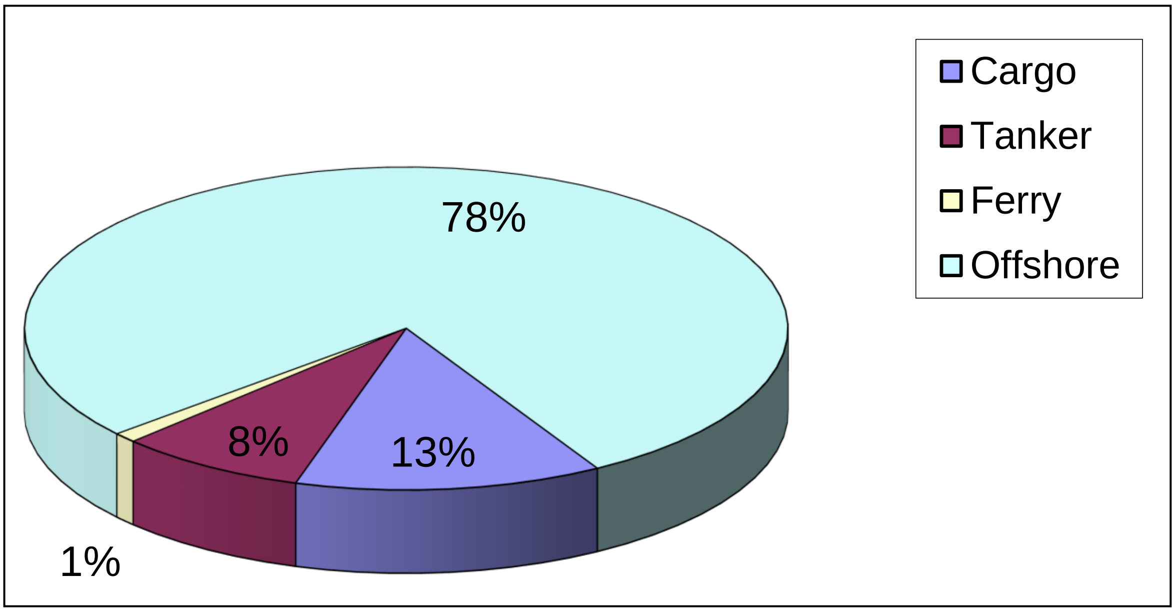


Figure 5.24: Vessel type distributions within 10 n miles of the Murchison Platform

Source: Anatec (2012)

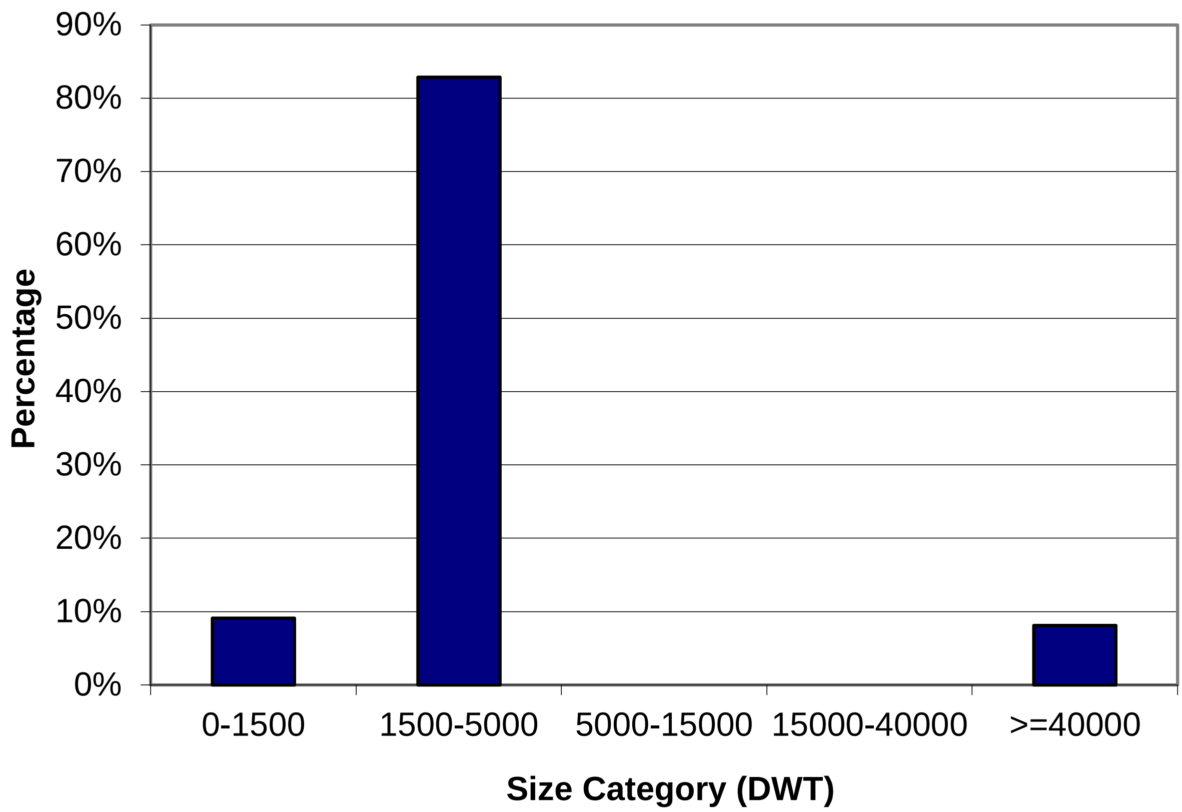


Figure 5.25: Vessel size distributions within 10 n miles of the Murchison Platform

Source: Anatec (2012)

5.4.5 Defence

There is no known military activity in the vicinity of the Murchison Facilities, nor any recorded munitions dumping grounds (DTI, 2001).

5.4.6 Telecommunications and Cables

There are no known submarine telecommunication and power cables within the vicinity of the Murchison Facilities (DTI, 2001).

5.4.7 Wrecks

There are no recorded wrecks in the vicinity of the Murchison Facilities (DTI, 2001).

5.5 Summary of Seasonal Environmental Sensitivities

Table 5.21 provides a summary of the seasonal sensitivities in the vicinity of the Murchison Facilities.

Table 5.21: Seasonal environmental sensitivities in the vicinity of the Murchison Facilities

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 Murchison Facilities area. Although *Lophelia pertusa* has colonised the Murchison Platform, it would not have occurred without the presence of the platform and therefore does not as constitute an Annex I habitat (Fugro ERT, 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 Murchison Facilities area, with very high abundance in February and July, and low numbers throughout the summer months (May, June, August and September) (DECC, 2009b; SMRU, 2001).											
Low	Very high	Low	Low	Moderate	Moderate	Very high	Moderate	Moderate	Low	Low	Low
Benthic Fauna Benthic communities in the Murchison Facilities 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 (Fugro ERT, 2013).											
Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Plankton The plankton in the Murchison Facilities 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 Murchison Facilities are located in spawning grounds for cod (Jan to Apr), whiting (Feb to Jun), haddock (Feb to May), Norway pout (Jan to Apr) and saithe (Jan to Apr); and in nursery grounds for herring, ling, mackerel, spur dog, haddock, Norway pout and blue whiting (throughout the year) (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 Murchison Facilities area include minke whales, long-finned pilot whales, killer whales, white-beaked dolphins, white-sided dolphins, harbour porpoises and sperm whales. Peak sightings generally occur from May to September (Reid *et al*., 2003; UKDMAP, 1998).											
Low	Very high	Low	Low	High	High	Very high	Very high	Moderate	Moderate	Low	Low
Seabirds Seabird vulnerability to oil pollution in the Murchison Facilities area is “high” in March, July, October and November and “moderate” to “low” for the rest of the year. The overall vulnerability in the Murchison Facilities area is “low” (JNCC, 1999).											
Moderate	Moderate	High	Low	Moderate	Low	High	Low	Moderate	High	High	Low
Fisheries The Murchison Facilities area is of “low” to “very low” relative value. Fishing effort is “low” to “very low” and dominated by demersal gear types. However, pelagic species historically dominate the landings in the vicinity of the Murchison Facilities area targeting mostly mackerel and herring (Marine Scotland, 2012, 2011b).											
Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low	Low
Shipping Shipping traffic in a 10 n miles area of the Murchison Facilities ranged from low to high in density (Anatec, 2012).											
Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate

Key

- Very high sensitivity
- High sensitivity
- Moderate sensitivity
- Low sensitivity
- Not surveyed/No data available

6.0 STAKEHOLDER VIEWS

This section details CNRI's engagement programme (2010 to date, and ongoing) which elicited views on a range of environmental issues from across the spectrum of stakeholders. The engagement programme is detailed fully in the stakeholder engagement report (CNRI, 2013).

6.1 Preliminary Engagement with Regulators

During the EIA scoping exercise, CNRI held meetings with DECC and other statutory consultees relating to the collection of background environmental data used to inform the EIA process. Records of the key issues raised during these meetings are summarised in Table 6.1.

Table 6.1: Summary of key issues raised by regulatory agencies during early discussions

Stakeholder	Comment	Influence on EIA
DECC Environmental Management Team (EMT), Marine Scotland and Joint Nature Conservation Committee (JNCC)	CNRI conducted a pre-decommissioning environmental baseline survey around the Murchison Platform. CNRI consulted with DECC, Marine Scotland and JNCC on the proposed scope of work for this survey. All parties confirmed that the Murchison survey scope of work met their requirements.	N/A
SEPA	Meetings with SEPA were held to secure input on radiological issues. An internal file note on NORM and the history of the platform has been prepared, noting levels (in Becquerels) of what has been recovered. Cleaning work and intelligent pigging has been used to keep pipeline scale under control. Topsides will have to be examined separately on actual cessation of production as part of the EDC scope before removal begins.	Discussion within Section 12.
JNCC	CNRI discussed the presence of *Lophelia pertusa* on the legs of the Murchison Platform and requested advice from JNCC with regard to the definition of 'significant' growth that would trigger the requirement for an Appropriate Assessment. JNCC formally responded in writing (8 December 2010): JNCC recommend an assessment of the extent and distribution of *L. pertusa* on the legs of the installation to be reported in the ES, to present an interpretation of the significance of the occurrence. JNCC advise that as *L. pertusa* would not have occurred without the presence of the platform, mortality as a result of decommissioning operations would not be considered as an issue of significant concern for the EIA.	Regular assessments of the marine growth on the Murchison Platform have been conducted during 2002, 2004, 2006 and 2010. The extent of *Lophelia pertusa* growth was recorded during each of the surveys and results are reported and assessed in the decommissioning EIA. Discussion within Sections 5, 12 and Appendix B

6.2 Stakeholder Engagement on the Murchison EIA Scoping Report

CNRI subsequently released the first revision of the Murchison Decommissioning EIA Scoping Report (BMT Cordah, 2011a) onto their website on 7 June 2011. In parallel, a wide range of consultees and interested parties were contacted on an individual basis to raise awareness of the Murchison Facilities Decommissioning Programme and to invite comment on the EIA scoping report. CNRI provided individual responses to stakeholder comments describing how any concerns will be addressed within the final Murchison ES. The main points raised by stakeholders by the time of release of the second draft of the Murchison Decommissioning EIA Scoping Report (17 February 2012) are summarised as follows:

- Contamination of the marine environment is considered to be the most important issue and modelling of the fate of the contaminants is encouraged.
- There may be significant fishing activity within the Murchison Facilities area by vessels registered in countries outside UK.
- It is very important to consider the "legacy" impacts of anything left behind and compare these with the short-term impacts of the actual decommissioning work.
- Marine growth may fall off the structure during transit to or at the demolition yard, which has the potential to introduce invasive marine species.
- The Murchison jacket may be currently acting as an artificial reef providing shelter for fish; removal of the jacket will remove any positive impacts that may be associated with fish recruitment.
- Cumulative impacts of leaving pipelines in place should be considered.
- Impacts associated with resource usage and atmospheric emissions should be considered for all decommissioning options.

6.3 Summary of all Stakeholder Engagement Responses

Following the release of the second draft of the Murchison EIA Scoping Report, CNRI held a stakeholder engagement workshop (held on a non-attributable basis to encourage open engagement) and various bi-lateral meetings to discuss the options for Murchison decommissioning being considered within the CA process.

Issues raised by stakeholders were used to inform the CA process and to identify a recommended option. The results of the CA and the recommended options were subsequently shared with the stakeholders through the issue of the draft CA report and a one day workshop (8 November 2012) to explore the contents.

Table 6.2 summarises all environmental issues raised by stakeholders during the CA process and provides CNRI’s response and location of response in the ES.

Table 6.2: Environmental issues raised in relation to the Murchison EIA Scoping Report and CA Process

Issue Raised by Stakeholder	Influence on the Murchison EIA	Location within ES
The presence of *Lophelia pertusa* on the legs of the platform requires an assessment of the extent and distribution, to allow an interpretation of the significance of the *Lophelia pertusa* occurrence.	CNRI have undertaken an assessment of the *Lophelia pertusa* on the legs of the platform. The results have been included within the ES. However, the JNCC have advised CNRI that as *Lophelia pertusa* would not have occurred without the presence of the platform, mortality as a result of decommissioning operations will not be considered as an issue of significant concern for the EIA.	Section 5
Contamination of the marine environment is considered to be the most important issue and modelling of the fate of contaminants encouraged.	CNRI commissioned two reports to investigate the long term cutting pile management and the effects of human disturbance of the cuttings pile (Genesis 2012a and 2012b).	Section 10 Section 13
NORM will need to be fully addressed in the course of time: not many companies are good at dealing with this and precedents will be set by the way this is handled.	Discussions regarding the management of NORM are ongoing with SEPA.	Section 12 Appendix B
Legacy issues must be given full consideration and compared with the short-term impacts of the actual decommissioning work.	The EIA assesses legacy issues associated with the Murchison Decommissioning Programme and the CA process assesses and balances the long-term legacy impacts of each option against the short-term operational impacts.	Section 10
Marine growth may fall off the jacket structure during transit to or at the demolition yard, which has the potential to introduce invasive marine species.	The EIA scope was amended to incorporate assessment of this concern and a technical note prepared. The issue was addressed in the CA process. Marine growth reports commissioned by CNRI indicated that the species of marine growth present on the Murchison jacket are typically found within the wider North Sea area with no rare or unusual species recorded.	Appendix B Section 12
The potential for the jacket to act as an artificial reef providing shelter for fish and its removal could impact adversely on fish recruitment.	CNRI has noted the potential of the jacket structure to act as an artificial reef due to the large volume of marine growth. The presence of the marine growth may increase fish abundance. However, if the jacket structure had not been in place for the last 40 years, such marine growth and fish aggregations would not be present. Therefore, the impact of jacket removal is regarded as short-term and negligible and its removal would not have the potential to impact on fish recruitment. The main commercial spawning species found in the Murchison area have historical and resilient spawning locations (Fox *et al*., 2008) and are rather influenced by natural events such as currents, eddies and gyres that create nutrient enriched locations.	Section 5 Section 11
Impacts associated with resource use and atmospheric emissions should be considered for all decommissioning options.	An energy and emissions report was prepared to inform the CA and EIA processes.	Section 8

Table 6.2 (continued): Environmental issues raised in relation to the Murchison EIA Scoping Report and CA

Issue Raised by Stakeholder	Influence on the Murchison EIA	Location within ES
An environmental baseline survey should be undertaken to provide a more complete picture than initially provided by historical data.	This was completed to inform the CA and EIA processes.	Section 5
Seabed disturbance impacts from removal operations (particularly those associated with drill cuttings) must be assessed, together with noise impacts.	Both seabed disturbance and noise impacts of all decommissioning activities are addressed within this ES.	Section 10 Section 9
Need for recognition that transportation of drill cuttings onshore for landfill could be an issue in Scotland because of space limitations and energy/emissions during transportation.	Drill cuttings will not be transported to shore for landfill.	Appendix B Section 12
Knowledge of what is inside the drill cuttings pile is a critical question to answer before decisions are made.	This is acknowledged as a critical issue. It is difficult to access the core with current technology. To try to build the most accurate picture possible in the absence of suitable technology, historic data has been used to model the pile core and its long term fate as it degrades. The location of the pile under the main jacket structure creates serious access problems for large coring devices. As such, assessment will be made on the basis of core samples and cuttings pile modelling to develop the best management option for assessment in line with OSPAR recommendations.	Section 10
Potential of jacket degradation to impact on drill cuttings pile after 1,000 years.	Assessment will be made on the basis of core samples and cuttings pile modelling to develop the best management option for assessment in line with OSPAR recommendations.	Section 10
Drill cuttings reinjection must be considered.	The CA process reviews this option.	Not Applicable
The possibility of contamination of nets/catches from the drill cuttings pile and spread of pile cuttings by nets must be considered.	Marine Scotland advises that overtrawl field studies have shown little displacement of cuttings from fishing nets. Documentation is cited by OSPAR in its 'Assessment of the possible effects of releases of oil and chemicals from any disturbance of cuttings piles' (2009c update) as 'FSR-ML. Fishing Gear Interference with Cuttings Piles beneath Oil Installations after their Decommissioning – the consequences for contamination spread; Fisheries Research Services Marine Laboratory Aberdeen (unpublished draft report finalised in 2000)'. CNRI have obtained a Report on Decommissioning Trawl Sweeps of the Hutton TLP from the SFF. The report indicated that trawling ground gear through the Hutton TLP drill cuttings resulted in the gears and doors (starboard and port) being covered in a muddy substance with a very strong oily smell (SFF, 2003).	Section 11

Table 6.2 (continued): Environmental issues raised in relation to the Murchison EIA Scoping Report and CA

Issue Raised by Stakeholder	Influence on the Murchison EIA	Location within ES
If any contractor proposes the use of explosives for jacket removal, there will be a need to properly assess vibration and noise impacts on sea mammals. Scottish Association for Marine Science (SAMS) has undertaken work which shows the potential for significant damage to sea mammal hearing from explosives and this should be assessed.	The use of explosives is not anticipated to cut jacket members or any of the associated subsea equipment. (Were the use of explosives to be subsequently proposed by a contractor, appropriate assessment would be required).	Section 4
Vessel movements (notably increased levels if, e.g. drill cuttings are transported to shore for treatment) have the potential for impacts on water flows and air/water interface which could affect birds (including flightless birds). Assessment would be useful to identify whether there was an issue for birds. FAME project will, in time, provide more reference material. See www.fameproject.eu/en/.	This is assessed within Appendix B.	Appendix B
Although we have referred to food chain/ecosystem issues arising from drill cuttings pile disturbance releasing contaminants, the effect on plankton plumes and sandeels was particularly noted as an issue.	This is assessed within Section 10 and Appendix B	Section 5 Section 10 Appendix B
Drill cuttings pile, if left *in situ*: drill cuttings management options should look at the potential for the use of plasticised/alginate covers for cuttings which would hold them in place for longer and allow natural degradation underneath over time; or for sealing-in methods to be used with a biological degrading agent to speed up degradation.	CNRI commissioned two reports to investigate long term cutting pile management and the effects of human disturbance of the cuttings pile (Genesis 2012a and 2012b). This was considered within the CA.	Section 10 Section 13
The potential risk of disturbance to the drill cuttings pile and any release of its contents as a result of other operations (e.g. conductor, pipeline and bundles removal) are to be fully understood.	CNRI have covered this risk within the EIA's assessment of environmental hazards and environmental impact assessment and is included within the ES.	Section 10

Table 6.2 (continued): Environmental issues raised in relation to the Murchison EIA Scoping Report and CA

Issue Raised by Stakeholder	Influence on the Murchison EIA	Location within ES
The potential environmental impacts associated with the introduction of new rock material compared to the removal and/or *in situ* option has to be determined by CNRI.	CNRI re-examined the recommendation for rock-placement on pipeline PL115 as opposed to cutting and lifting the 17 exposed sections along its length. The rock-placement option remained the most appropriate option for both safety and environmental mitigation measures. In addition, CNRI conducted a habitats assessment based on existing data for pipeline PL115. No Annex I Habitats were found to be present along the pipeline corridor.	Section 5
A query was raised during the 8 November stakeholder engagement workshop which could give rise to further studies: 1. The impact of a tsunami on the drill cuttings piles if it were to be decommissioned *in situ*.	CNRI considered the query, however, upon further investigation it was not deemed to be an issue that changed the recommendations of the CA.	Not Applicable
Confirmation from CNRI regarding what the modelling for drill cuttings comprises.	Recorded data regarding drilling discharge and the different types of mud discharges was reviewed and used to construct the Murchison drill cuttings pile in the model. Comparison of modelled cuttings pile versus the actual cuttings pile was made. A good correlation was found between the modelled and actual cuttings pile. CNRI looked at the rate of biological degradation and leaching and the persistence of the pile in relation to the OSPAR thresholds. All aspects were found to be below the OSPAR limits. Modelling also included the collapse of the jacket footings and the likely impact on the drill cuttings piles in the future. The results of the modelling were included within the ES.	Section 10 – Seabed Disturbance Also see references within Section 10 to Drill Cuttings Pile Modelling and Drill Cuttings Options Management Report.
Confirmation from CNRI that the cumulative impact of decommissioning has been considered.	CNRI can confirm that cumulative environmental impacts have been considered in the ES and supporting studies.	Sections 8 to 10.
Confirmation from CNRI that environmental monitoring will be undertaken post-decommissioning	Surveys will be undertaken after the decommissioning operations end; an initial debris survey after decommissioning operations end followed by a survey 3 to 4 years later, they will be revised in conjunction with the regulator.	Section 4 Section 14

7.0 RISK ASSESSMENT

The activities associated with the decommissioning of the Murchison Facilities have potential to cause environmental impacts in several ways. This section describes the process used to identify and assess the relative significance of the potential environmental impacts associated with these activities.

7.1 Risk Assessment Process

The purpose of the risk assessment process is to identify potentially significant impacts, so that they can be more fully assessed and mitigated as necessary. Potential impacts are evaluated in terms of the magnitude of the environmental impact or risk of the activity and the sensitivity of the receiving environment or environmental receptor, taking into account the location (where applicable) and the time of year the activity is taking place.

7.1.1 Environmental Impacts Identification Workshop

A facilitated Environmental Impacts Identification workshop was held to identify the range of high level environmental impacts which might occur as a result of the proposed decommissioning of the Murchison Facilities and which would need further consideration. The workshop considered the planned and unplanned/accidental events that might occur during the lifetime of the proposed decommissioning of the Murchison Facilities (BMT Cordah, 2012b).

The purpose of the workshop was to scope the potential environmental risks associated with the decommissioning of the Murchison Facilities, by examining all the proposed activities and their potential interaction with environmental receptors. The workshop had the following objectives:

- To ensure that the project team was aware of the main environmental sensitivities within the sphere of influence of the decommissioning of the Murchison Facilities.
- To ensure that participants had a common, shared understanding of the proposed activities.
- To emphasise the regulatory requirements of the EIA and ES process.
- To highlight the activities, both planned and unplanned or accidental, which would require further detailed examination within the ES and to screen out those which would require less detailed assessment.
- To ascertain and discuss any project-specific mitigation measures that might be needed for the decommissioning of the Murchison Facilities, in addition to the industry-standard measures that would be automatically applied to a project of this nature.
- To highlight any important data gaps.
- To identify the actions needed to complete the EIA process and ES.

7.2 Assessing the Risk

The following section details the assessment criteria used during the risk assessment process to consider the possible sources of potential impact and to judge the significance of each on aspects of the receiving environment.

7.2.1 Impact Identification

The first step in the risk assessment is to identify (i) the different activities or sources of potential environmental impact or risk associated with each phase of the proposed decommissioning of the Murchison Facilities, and (ii) the receiving environmental media that could be affected.

The impacts that might arise during the Murchison Facilities decommissioning project were identified by:

- Examining the proposed options for decommissioning the Murchison topsides, jacket and subsea infrastructure and identifying the specific activities within each of these high level decommissioning phases which may give rise to an environmental impact. The high level activities were identified as:
  - the use of vessels and offshore transportation, during all types of offshore operations;
  - post CoP activities: P&A of wells;
  - conductor recovery, topsides EDC and preparation;
  - decommissioning of topsides;
  - decommissioning of the jacket;
  - decommissioning of the pipeline PL115;
  - decommissioning of the bundles PL123, PL124, PL125;
  - decommissioning of Murchison and Dunlin A spoolpieces, umbilical approach to Murchison and subsea wells;
  - decommissioning of the drill cuttings pile; and
  - the handling, dismantling, treatment and disposal of materials at inshore and onshore sites
- Assessing the characteristics and sensitivities of the offshore environment in which the Murchison Facilities are located (Section 5). These receptors fall within four broad categories: physical environment, biological environment, human aspects and other considerations.

7.2.2 Risk Assessment Method

Potential risks associated with the proposed decommissioning of the Murchison Facilities were assessed using an environmental risk assessment matrix which combined two measures, the severity of an impact and the likelihood that it would occur (Tables 7.1 to 7.4). The likelihood that an impact would occur was assessed using the definitions specified in the CNRI Management of Aspects and Impacts Procedure (SHE-PRO-314) (Table 7.1).

Table 7.1: Definition of likelihood of occurrence (SHE-PRO-314)

Likelihood	Definition
1. Very Unlikely	A freak combination of factors would be required for an incident to result. An incident has occurred within the UKCS in the past. No direct or associated impact on emissions will result from process/equipment failure or malfunction.
2. Unlikely	A rare combination of factors would be required for an incident to result. An incident has occurred on a CNRI platform in the past. Unlikely that failure or malfunction of process/ equipment will have impact on emissions.
3. Possible	Could happen if a number of additional factors are present, but otherwise unlikely to occur. An incident has occurred within the named platform's lifetime. Possible that failure or malfunction of process/equipment will impact on emissions.
4. Likely	Not certain, but incident could occur with only one normally-occurring additional factor. An incident has occurred within the past year on the named platform. Likely that failure or malfunction of process/equipment will impact on emissions.
5. Very Likely	Almost inevitable that an incident will occur under the circumstances. An incident has happened several times on the platform within the last year or the impact on the environment is part of a continuous operation. Certain that failure or malfunction of process/equipment will impact on emissions.

The consequence of an impact occurring as a result of emergency or non-routine events was assessed using the definitions specified in the CNRI Management of Aspects and Impacts Procedure (SHE-PRO-314), and the consequence of an impact occurring as a result of planned events was assessed using the definitions specified in the UKOOA Offshore Environmental Statement Guidelines (1999a) (Table 7.2). The definition for consequence outlined in the CNRI Management of Aspects and Impacts Procedure is specific to a process loss, therefore the UKOOA guidelines were used to support this definition for the assessment of impacts unrelated to process loss.

The likelihood and consequence factors were combined using the risk assessment matrix (Table 7.3) to determine the level of risk each aspect of the project could pose to environmental receptors, physical, chemical, biological, human and other considerations.

The overall significance for each aspect was determined by taking the highest severity of impact (Table 7.2) associated with the event against any one of the environmental receptors and combined with the likelihood of the event from Table 7.1. The definition of environmental risk is presented in Table 7.4.

Table 7.2: Definition of consequence of occurrence (SHE-PRO-314)

Severity	Definition (CNRI, SHE-PRO-314)	Definition (UKOOA Offshore Environmental Statement Guidelines (1999a)
0. None	-	No interaction and hence no change expected.
Beneficial	-	Likely to cause some enhancement to the ecosystem or activity within the existing structure. May help local population.
1. Negligible	No loss to the external environment. No regulatory exposure.	Change which is unlikely to be noticed or measurable against background activities. Negligible effects in terms of health or standard of living.
2. Slight	Potential loss to the external environment from a system or process does not exceed 1 tonne.	Change which is within the scope of existing variability, but can be monitored and/or noticed. May affect behaviour, but not a nuisance to users or public.
3. Moderate	Potential loss to the external environment from a system or process is between 1 and 25 tonnes. There is a breach of consent and/or legislative conditions which is unlikely to result in prosecution from Regulators.	Change in the ecosystem or activity in a localised area for a short time (< 2 years), with good recovery potential. Similar scale of effect to existing variability, but may have cumulative implications. Potential effect on health, but unlikely. May cause nuisance to some users.
4. High	Potential loss to the external environment from a system or process is between 25 and 100 tonnes. There is a breach of consent and/or legislative conditions with potential for prosecution from Regulators.	Change in the ecosystem or activity over a wide area leading to medium-term (>2 years) damage, but with a likelihood of recovery within 10 years. Possible effect on human health. Financial loss to users or public.
5. Very high	Potential loss to the external environment from a system or process of greater than 100 tonnes. There is a breach of consent and/or legislative conditions with a strong likelihood of prosecution from Regulators.	Change in the ecosystem leading to long-term (>10 years) damage and poor potential for recovery to a normal state. Likely to affect human health. Long-term loss or change to users or public finance.

Table 7.3: Risk Potential Matrix Summary

Likelihood of Occurrence	Severity				
	Negligible	Slight	Moderate	High	Very High
Very unlikely	1	2	3	4	5
Unlikely	2	4	6	8	10
Possible	3	6	9	12	15
Likely	4	8	12	16	20
Very likely	5	10	15	20	25

Table 7.4: Definition of Environmental Risk

Score	Level of Significance	Environmental Risk Definition
1-6	Low significance	Risk acceptable: review annually and continue with current management controls.
8-12	Moderate significance	Risk should be reduced: Identify opportunities for improvement through objectives and targets.
15-25	Significant	Risk unacceptable: Immediate action required to reduce risk to an acceptable level.

7.3 Risk Assessment Results

The results of the risk assessment and Environmental Impacts Identification workshop are presented within Appendix B and summarised within Tables 7.5 to 7.13. The output was a list of potential effects and activities which would need to be considered further in the ES (Section 7.3.1).

Table 7.5: Risk Assessment: sources of potential environmental impacts and receiving environment associated with the use of vessels during all decommissioning activities

Use of vessels Key Significant Moderate Low	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	ES Section
The use of vessels and offshore transportation during all types of offshore operations																					
Physical presence of vessels outside 500 m zone												✓	✓							L	App B
Vessel movement and station keeping								✓	✓									✓	✓	M	9
Anchoring on seabed		✓	✓			✓		✓												L	App B
Anchoring on contaminated sediments within 500 m of the platform but not on the drill cuttings pile		✓	✓			✓	✓	✓												L	App B
Vessel discharges e.g. sewage			✓			✓	✓	✓				✓								L	App B
Vessel discharges e.g. ballast water inshore			✓			✓	✓	✓												L	App B

Use of vessels Key: Significant / Moderate / Low	Environmental Receptors																			
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	ES Section
Power generation for vessel operation	✓			✓														✓	✓	L	App B
Vessel movement inshore															✓					L	App B
Emergency and non-routine events																					
Vessel collision with another vessel leading to vessel sinking.		✓	✓			✓	✓	✓				✓	✓	✓					✓	L	App B
Major oil spill as a result of vessel collision with another vessel (>100 t fuel oil)		✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓			✓	✓	✓	L	App B
Accidental fuel spills during decommissioning operations e.g. fuel bunkering			✓	✓			✓	✓		✓		✓							✓	M	13

Table 7.6: Risk Assessment: sources of potential environmental impacts and receiving environment associated with post COP activities

Post CoP Activities: P&A of wells, conductor recovery, topsides EDC and preparation

Key
- Significant
- Moderate
- Low

Post CoP Activities: P&A of wells, conductor recovery, topsides EDC and preparation	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Potential impacts associated with post CoP activities: P&A of wells, conductor recovery, EDC																					
Well P&A Tubing recovery		✓	✓			✓		✓											✓	L	App B
Well P&A cutting conductor								✓	✓									✓	✓	L	App B
Well P&A conductor recovery to surface.								✓												L	App B
EDC			✓				✓	✓											✓	L	App B
Topside preparation for removal using hot cutting, welding etc.			✓	✓			✓	✓												L	App B
Power generation for running topsides during well P&A activities through continued operation of the two main power generators and temporary generators.	✓			✓														✓	✓	L	App B

Emergency and non-routine events

CNR International

Post CoP Activities: P&A of wells, conductor recovery, topsides EDC and preparation Key Significant Moderate Low	**Environmental Receptors**																				
	Physical					**Biological**						**Human**					**Other**				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Loss of minor /small items e.g. scaffold within 500 m of the platform.		✓				✓		✓												L	App B
Conductor dropped during recovery within 500 m of the platform.		✓				✓		✓				✓								L	App B

Table 7.7: Risk Assessment: sources of potential environmental impacts and receiving environment associated with topside decommissioning.

Key: Significant (red), Moderate (yellow), Low (green)

Topside decommissioning	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Potential impacts associated with topsides decommissioning: both reverse installation & piece-small removal																					
Power generation for the manufacture of temporary steelwork.	✓			✓														✓	✓	L	App B
Power generation for vessel operations.	✓			✓														✓	✓	L	App B
Vessel discharges e.g. sewage.			✓				✓	✓												L	App B
Power generation for dismantling structures inshore.	✓			✓														✓	✓	L	App B
Power generation for onshore transportation of recovered material to recycling site or landfill facility.	✓			✓														✓		L	App B
Option 1: Reverse Installation (Duration 150 or 280 days depending on sub-option)																					
Power generation for module separation and cutting (plasma, flame or cold cutting).	✓			✓														✓	✓	L	App B
Module separation and cutting (plasma, flame or cold cutting).			✓	✓			✓	✓												L	App B

Topside decommissioning Key Significant Moderate Low	**Environmental Receptors**																				
	Physical					**Biological**						**Human**					**Other**				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Power generation for heavy lift vessel at site, during transportation to shore and transfer of modules to cargo barge.	✓			✓														✓	✓	L	App B
Mooring of cargo barge to support HLV.		✓	✓			✓		✓												L	App B
Power generation for dismantling structures inshore.	✓			✓														✓	✓	L	App B
Dismantling structures/ recovered material onshore.				✓											✓					L	App B
Option 2: Piece-small removal																					
Offshore dismantling including hot/ cold cutting, excavators or demolition robots.	✓			✓														✓	✓	L	App B
Offshore dismantling including hot/cold cutting, excavators or demolition robots.			✓	✓																L	App B

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Topside decommissioning	Environmental Receptors																				
Key: Significant (red), Moderate (yellow), Low (green)	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Presence of accommodation support vessel		✓	✓			✓		✓												L	App B
Increased supply boat activity.	✓			✓														✓	✓	L	App B
Increased supply boat activity resulting in vessel discharges			✓				✓	✓												L	App B
Power generation for vessel operation for HLV lift of accommodation block and MSF activity.	✓			✓														✓	✓	L	App B
Emergency and non-routine events																					
Module loss during lifting and transportation.		✓	✓			✓		✓											✓	L	App B
Loss of minor items during module separation e.g. scaffold within 500 m of the platform.		✓				✓		✓												L	App B

Table 7.8: Risk Assessment: sources of potential environmental impacts and receiving environment associated with jacket decommissioning.

Jacket decommissioning Key Significant Moderate Low	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Potential impacts from jacket decommissioning operations: partial (-113 m depth) removal, for conventional heavy lift, single lift and small crane vessel																					
Power generation for manufacture of temporary steelwork.	✓			✓														✓	✓	L	App B
Vessel discharges e.g. sewage.			✓				✓	✓												L	App B
Power generation for vessel operations.	✓			✓														✓	✓	L	App B
Power generation for dismantling structures inshore.	✓			✓														✓	✓	L	App B
Dismantling structures/recovered material onshore.				✓											✓					L	App B
Power generation for onshore transportation of recovered material to recycling site or landfill facility.	✓			✓														✓		L	App B
Offshore removal of marine growth from whole jacket using high pressure jet cleaner.		✓	✓			✓		✓											✓	L	App B

Jacket decommissioning Key Significant (red) Moderate (yellow) Low (green)	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Power generation underwater cutting of jacket legs and members (techniques include DWC, AWJ, hydraulic shear).	✓			✓														✓	✓	L	App B
Underwater cutting (techniques include DWC, AWJ, hydraulic shear).								✓	✓									✓	✓	L	App B
Power generation for underwater cutting (techniques include DWC, AWJ, hydraulic shear).	✓			✓														✓	✓	L	App B
Cut through diesel storage tanks in jacket legs during platform removal.			✓				✓	✓												L	App B
Potential impacts associated with BTA jacket flotation and grounding at inshore fjord - partial removal (-113 m depth) (726 days demolition within fjord location)																					
Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway (physical disturbance to seabed).		✓	✓			✓	✓	✓												M	10
Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway (potential introduction of invasive species and marine growth.						✓	✓	✓												L	App B

Jacket decommissioning Key Significant (red) Moderate (yellow) Low (green)	Environmental Receptors																			
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway (deterioration in seawater quality and localised increase in biological oxygen demand BOD).												✓								L	App B
Cutting the partial jacket into sections at inshore site for transportation to shore– 113 m water depth, at Hille near Aker Stord, Norway.								✓	✓									✓	✓	M	10
Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway (long-term presence).															✓					L	App B
Potential impacts from leaving jacket footings *in situ*																					
Physical presence of jacket footings left *in situ* (reef effect).						✓		✓				✓								L	App B
Physical presence of jacket footings left *in situ* (commercial consequences of snagging fishing gear on the jacket footings).												✓					✓			M	10

Jacket decommissioning	Environmental Receptors																				
Key: Significant / Moderate / Low	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Physical presence of jacket footings left *in situ* (loss of access for commercial fisheries).												✓								L	App B
Physical presence of jacket footings left *in situ* (release of contaminants from degrading metal footing and anodes which may contain components toxic to marine life).		✓	✓			✓	✓	✓												L	App B
Long-term degradation of footings leading to falling jacket members and structures.		✓	✓			✓	✓	✓												L	10
Power generation for new manufacture to replace recyclable material left on the seabed.	✓			✓														✓		L	App B
Emergency and non-routine events relating to jacket decommissioning																					
Large dropped objects, e.g. jacket, jacket sections.		✓				✓		✓				✓							✓	L	App B

Table 7.9: Risk Assessment: sources of potential environmental impacts and receiving environment associated with pipeline decommissioning: pipeline PL115.

Key: Significant (red); Moderate (amber); Low (green)

Pipeline PL115 decommissioning	Environmental Receptors: Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Rock-placement over exposed sections of the pipeline and remove spoolpieces at pipeline ends [PL115: Duration= 12 days]																					
Rock-placement over exposed sections of pipeline and pipeline ends (leading to a modification of natural seabed characteristics and seabed habitat).		✓				✓		✓												M	10
Rock-placement over exposed sections of pipeline and pipeline ends (physical disturbance causing suspension of material).		✓	✓			✓		✓												M	01
Rock-placement over exposed sections of pipeline and pipeline ends (generation of underwater noise causing potential disturbance to marine life).								✓	✓									✓		L	App B
Physical presence of rock material.												✓					✓	✓		L	App B

Table 7.10: Risk Assessment: sources of potential environmental impacts and receiving environment associated with bundle decommissioning: bundles PL123, PL124, PL125

Bundle decommissioning: bundles PL123, PL124, PL125 Key Significant Moderate Low	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Full removal of bundle in sections (Cut and lift) [Bundles = 90 days (including 2 weeks underwater cutting]																					
Power generation for vessel operations.	✓			✓														✓	✓	L	App B
Vessel discharges e.g. sewage.			✓				✓	✓												L	App B
Power generation for dismantling structures inshore.	✓			✓														✓	✓	L	App B
Power generation for onshore transportation of recovered material to recycling site or landfill facility.	✓			✓														✓		L	App B
Cut bundle into sections using hydraulic shears.		✓	✓			✓		✓												L	App B
Install hydraulic clamps on a spreader to the bundle sections and lift sections onto the vessel.		✓	✓			✓		✓												L	App B

Bundle decommissioning: bundles PL123, PL124, PL125 Key Significant Moderate Low	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Removal of bundle PL125 which is covered by some drill cuttings where it connects to Murchison Platform.		✓	✓			✓	✓	✓											✓	L	10
Potential impacts from completely removing bundles																					
Complete removal of bundles.												✓								L	App B
Emergency and non-routine events relating to bundle decommissioning																					
Accidentally dropped sections of bundles during removal operations.		✓				✓		✓												L	App B

Table 7.11: Risk Assessment: sources of potential environmental impacts and receiving environment associated with decommissioning of Murchison subsea wells.

Key: Significant (red); Moderate (yellow); Low (green)

Decommissioning of Murchison subsea wells	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Murchison Subsea Wells																					
Power generation for vessel operations.	✓			✓														✓	✓	L	App B
Vessel discharges e.g. sewage.			✓				✓	✓												L	App B
Power generation for dismantling structures inshore.	✓			✓														✓	✓	L	App B
Power generation for onshore transportation of recovered material to recycling site or landfill facility.	✓			✓														✓		L	App B
Disconnection and recover of protective structures and guide bases.		✓	✓			✓	✓	✓												L	App B
Disconnection and recover of protective structures and guide bases.			✓				✓	✓											✓	L	App B
Emergency and non-routine events relating to wellhead decommissioning																					
Dropped objects.		✓				✓		✓												L	App B

Table 7.12: Risk Assessment: sources of potential environmental impacts and receiving environment associated with drill cuttings pile management.

Drill cuttings pile management Key Significant Moderate Low	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Potential impacts associated with the cuttings pile management options																					
Leave *in situ* and do nothing (leaching of contaminants including hydrocarbon and metals into the water column from an undisturbed cuttings pile).		✓	✓			✓	✓	✓										✓	✓	L	App B
Leave *in situ* and do nothing (long-term pile presence and contaminant persistence leading to continued impact on sediment quality and benthic communities from an undisturbed cuttings pile).		✓				✓		✓				✓					✓	✓		L	App B

Table 7.13: Risk Assessment: sources of potential environmental impacts and receiving environment associated with deconstruction, manufacture and recycling of materials on or near-shore

Deconstruction, disposal, manufacture and recycling of materials on- or near-shore Key Significant Moderate Low	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore																					
Dismantling structures at an inshore location prior to transfer to an onshore dismantling yard.		✓	✓	✓		✓	✓								✓					L	App B
Power generation for dismantling structures inshore.	✓			✓														✓	✓	L	App B
Dismantling structures/ recovered material at an onshore dismantling yard.				✓											✓					L	App B
Presence of marine growth on jacket structure at inshore site.		✓	✓			✓		✓						✓						L	App B
Onshore cleaning marine growth from jacket, conductors, using high pressure jet cleaner.				✓											✓					M	12
Onshore disposal of marine growth.				✓	✓										✓					L	App B
Power generation for onshore transportation of recovered material to recycling site or landfill facility.	✓			✓														✓		L	App B

Deconstruction, disposal, manufacture and recycling of materials on- or near-shore Key Significant Moderate Low	Environmental Receptors																				
	Physical					Biological						Human					Other				
	Use of resources	Seabed sediments	Water column	Atmosphere	Use of disposal facilities	Benthos	Plankton	Fish & shellfish	Sea mammals	Sea birds	Conservation sites	Commercial fishing	Shipping	Other users of the sea	Communities	Socioeconomic	Stakeholder concerns	Cumulative impacts	Transboundary issues	OVERALL SIGNIFICANCE	Justification Section Reference
Power generation for recycling/ reprocessing	✓			✓														✓	✓	L	App B
Landfill disposal of non-recyclable materials.					✓															L	App B
Treatment and disposal of hazardous waste (including exempt NORM waste).	✓				✓															L	App B
Treatment and disposal of non-exempt NORM.	✓			✓																L	App B
Emergency and non-routine events																					
Unidentified non-exempt NORM mobilised onshore.					✓												✓			L	App B

7.3.1 Summary of Risk Assessment Results

A summary of the risk assessment results and predicted level of significance is presented within Table 7.14.

Table 7.14: Summary of the results from the risk assessment for identified impacts arising from the decommissioning of the Murchison Facilities.

Decommissioning Activities	Risk					
	Low		Moderate		Significant	
	Operational / Routine	Accidental Events / Non-routine	Operational / Routine	Accidental Events / Non-routine	Operational / Routine	Accidental Events / Non-routine
Use of vessels	7	2	1	1	0	0
Post CoP Activities: P&A of wells, conductor recovery, topsides EDC and preparation	6	2	1	0	0	0
Topside decommissioning	17	2	0	0	0	0
Jacket decommissioning	18	1	4	0	0	0
Pipeline PL115 decommissioning	2	0	2	0	0	0
Decommissioning of Murchison subsea wells	6	1	0	0	0	0
Drill cuttings pile management	2	0	0	0	0	0
Deconstruction, disposal, manufacture and recycling of materials on- or near-shore	10	1	1	0	0	0

Impacts considered to be of moderate significance, or which have been identified for assessment by DECC (Section 2.2) are assessed in greater detail within Sections 8 to13, including:

- Effects of energy use and atmospheric emissions (Section 8).
- Effects of underwater noise generated during decommissioning activities (Section 9).
- Effects of seabed disturbance during decommissioning operations - vessel anchoring, rock-placement, etc. (Section 10).
- Effects of drill cuttings disturbance (Section 10).
- Effects associated with Murchison cuttings pile management (Section 10).
- Physical presence of vessels causing potential interference with other users of the sea (Section 11).

- Socioeconomic impact to fishermen from the derogated footings and pipelines (Section 11).
- Cleaning of marine growth from the Murchison jacket (Section 12 and Appendix B).
- Landfill disposal and associated impacts (Section 12).
- Non-routine events – spillage of hydrocarbons and other fluids (Section 13).

Appendix B provides a summary of the justification and reasoning behind the screening out of the activities that were determined to have low risk and do not require more detailed assessment.

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8.0 ENERGY USE AND ATMOSPHERIC EMISSIONS

CNRI commissioned a study to assess energy use and the atmospheric emissions likely to arise for all the decommissioning options identified for the Murchison Facilities to inform the CA (Section 4, BMT Cordah (2012c)). This section summarises the findings of this report for the recommended decommissioning options. Mitigation measures to minimise emissions and optimise energy use are described.

8.1 Methodology

The energy and emissions assessment was based on the Institute of Petroleum (IoP) "Guidelines for the Calculation of Estimates of Energy Use and Gaseous Emissions in the Decommissioning of Offshore Structures" (IoP, 2000). The main steps of the assessment included:

- Establishment of a materials inventory for each structure to be decommissioned.
- Identification of all operations associated with decommissioning options.
- Identification of 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. For each operation and end point, identification of the associated activities that will be a source of energy use and atmospheric emissions.
- Selection of conversion factors and calculation of energy use and atmospheric emissions.

8.1.1 Energy and Emission Factors

The assessment predominantly used the energy use and emission factors provided within IoP (2000) guidelines. In accordance with these guidelines, alternative factors may be used where specific equipment is considered to have a significantly different fuel use from that presented in the IoP database. Appendix C details factors used for each aspect of the energy and emissions calculations: manufacture of new materials, recycling of materials, general fuel consumption, vessel fuel use and deconstruction of materials.

8.1.2 Regulatory Requirements

Atmospheric emissions generated from the decommissioning of the Murchison Facilities will be managed in accordance with current legislation and standards as detailed within Appendix A.

8.2 Potential Sources and Magnitude of Impact

The following section reports the findings of the energy and emissions assessment (BMT Cordah, 2012b) which considered, where appropriate, the following sources for each stage of the Murchison decommissioning:

- power generation on topsides post CoP;
- 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 (e.g. rock-placement and temporary steel work) required for decommissioning operations;
- recycling; and
- new manufacture to replace recyclable materials left at sea or disposed of in landfill.

8.2.1 Materials and Operations Inventories

Inventories of materials and operations are provided within Appendix C.

8.2.2 Topsides Activities Post CoP

Table 8.1 provides the estimated energy use during activities carried out from the Murchison platform after CoP and before decommissioning of the topsides, including running the topsides, cleaning and engineering-down and recovery of the conductors and platform wellheads.

The greatest energy use is attributed to vessel and helicopter use and power generation with 2.3 million GJ from power generation aboard the topsides.

Table 8.1: Energy use for topsides activities post CoP

Decommissioning Aspect	Energy use (GJ)
Manufacture of new materials required for decommissioning	0
Vessel and helicopter use and power generation	2,951,243
Onshore transportation	174.27
Onshore deconstruction	8,878
Recycling	66,807
New manufacture to replace recyclable materials left in situ or landfill	0
Total	**3,027,102**

8.2.3 Vessel Use

Table 8.2 summarises the vessels expected to be associated with the decommissioning of each Murchison Facility.

Table 8.2: Summary of vessel use during Murchison Facilities decommissioning

Murchison Facility	Recommended Decommissioning Option	Decommissioning Method	Vessel use
Topsides activities post CoP	Engineering-down, cleaning, wells P&A and conductor recovery	N/A	Standby vessel, supply vessel, ROV launched from the platform.
Topsides	Full removal	Reverse installation – Method A	HLV, cargo barge, two anchor handling vessels (AHV), supply vessel, standby vessel
		Reverse installation – Method B (using HLV)	HLV, cargo barge, two tugs, standby vessel, supply vessel
		Reverse installation – Method B (using HLV and CSV)	HLV, cargo barge, two tugs, CSV, standby vessel, supply vessel
		Reverse installation – Method C (over one season)	HLV, supply vessel, standby vessel, tug
		Reverse installation – Method C (two seasons)	HLV, supply vessel, standby vessel, tug
		Piece-small	HLV, waste carrier, standby vessel, supply vessel, flotel, two tugs
Jacket	Partial removal	Cut and lift – Method A	HLV, CSV, standby vessel
		Cut and lift – Method B	ROVSV, CSV, HLV, standby vessel
		Cut and lift – Method C	HLV, CSV, two cargo barges, two tugs, standby vessel
		Flotation in one piece	Survey vessel, three tractor tugs, two operational support vessels, crane barge, standby vessel, one inshore tug
Pipeline PL115	Remove spools at Murchison and Dunlin A and bury exposed sections	By rock-placement	Rock-placement vessel
Bundles	Full removal	Cut and lift	ROVSV, tug, barge
Subsea wellheads	Full removal	Cut and lift	DSV, tug, barge
Murchison & Dunlin A spool-pieces	Removal of Murchison and Dunlin A spool-pieces	n/a	ROV, DSV
Cuttings pile	Leave *in situ*	N/A	N/A

Sources: CNRI (2012c); CNRI (2011c, 2011d); Atkins (2011)

8.2.4 Topsides Decommissioning

Table 8.3 details the estimated energy use and atmospheric emissions for decommissioning the Murchison topsides for each method under consideration.

Table 8.3: Murchison topsides – predicted energy use and atmospheric emissions during decommissioning

Decommissioning Aspect	Energy (GJ)	CO_2 (tonnes)	NO_x (tonnes)	SO_2 (tonnes)	CH_4 (tonnes)
Reverse installation - Method A					
Manufacture of new components or materials required for decommissioning	37,500	2,833	5.25	8.25	No data
Vessel and helicopter use	251,974	18,708	344.93	23.39	1.58
Onshore transportation	558	40	0.51	0.01	No data
Onshore deconstruction	28,271	No data	No data	No data	No data
Recycling	241,887	18,817	29.88	424.85	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	0	0	0	0	0
Total	**560,190**	**40,398**	**380.57**	**456.50**	**1.58**
Reverse installation - Method B (using HLV)					
Manufacture of new components or materials required for decommissioning	37,500	2,833	5.25	8.25	No data
Vessel and helicopter use	202,560	15,039	277.29	18.80	1.27
Onshore transportation	558	40.3	0.51	0.01	No data
Onshore deconstruction	28,271	No data	No data	No data	No data
Recycling	241,887	18,817	29.88	424.85	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	0	0	0	0	0
Total	**510,776**	**36,729**	**312.93**	**451.91**	**1.27**
Reverse installation Method B (using HLV and CSV)					
Manufacture of new components or materials required for decommissioning	37,500	2,833	5.25	8.25	No data
Vessel and helicopter use	214,032	15,891	292.99	19.86	1.34
Onshore transportation	558	40	0.51	0.01	No data
Onshore deconstruction	28,271	No data	No data	No data	No data
Recycling	241,887	18,817	29.88	424.85	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	0	0	0	0	0
Total	**522,248**	**37,581**	**328.63**	**452.97**	**1.34**

Table 8.3 (continued): Murchison topsides – predicted energy use and atmospheric emissions during decommissioning

Decommissioning Aspect	Energy (GJ)	CO_2 (tonnes)	NO_x (tonnes)	SO_2 (tonnes)	CH_4 (tonnes)
Reverse installation Method C (over one season)					
Manufacture of new components or materials required for decommissioning	37,500	2,833.50	5.25	8.25	No data
Vessel and helicopter use	174,654	12,967	239.09	16.21	1.09
Onshore transportation	558.14	40	0.51	0.01	No data
Onshore deconstruction	28,271	No data	No data	No data	No data
Recycling	241,887	18,817	29.88	424.85	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	0	0	0	0	0
Total	**482,870**	**34,657.5**	**274.73**	**449.32**	**1.09**
Reverse installation Method C (over two seasons)					
Manufacture of new components or materials required for decommissioning	37,500	2,833	5.25	8.25	No data
Vessel and helicopter use	210,334	15,616	287.93	19.52	1.32
Onshore transportation	558	40.	0.51	0.01	No data
Onshore deconstruction	28,271	No data	No data	No data	No data
Recycling	241,887	18,817	29.88	424.85	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	0	0	0	0	0
Total	**518,550**	**37,306**	**323.57**	**452.63**	**1.32**
Reverse installation piece-small					
Manufacture of new components or materials required for decommissioning	15,000	1,133	2.10	3.30	No data
Vessel and helicopter use	459,338	34,048	616.09	42.56	2.83
Onshore transportation	558	40	0.51	0.01	No data
Onshore deconstruction	28,271	No data	No data	No data	No data
Recycling	241,887	18,817	29.88	424.85	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	0	0	0	0	0
Total	**745,054**	**54,038**	**648.58**	**470.72**	**2.83**

Each reverse installation method is predicted to use a similar amount of energy (approximately 500,000 GJ). Within the bounds of uncertainty of this assessment, it is not possible to distinguish between these sub-options. Piece-small deconstruction is predicted to use approximately 50% more energy than the reverse installation options, largely attributable to the use of vessels offshore over a longer period of time (approximately two years; CNRI, 2011d) to complete the deconstruction.

The largest proportion of energy use (approximately 40% to 60%) is from vessel operations. All options are assumed to result in the return to shore and where possible recycling of all topsides materials. No energy use is attributable to re-manufacture of materials left *in situ* or disposed of in landfill.

8.2.5 Jacket Decommissioning

Table 8.4 details the estimated energy use and atmospheric emissions for partial removal of the Murchison jacket for each decommissioning method under consideration.

With partial removal, the theoretical cost of re-manufacture for materials left *in situ* or taken to landfill is the greatest energy use, followed by vessel use and recycling. Each cut and lift option is predicted to use a similar amount of energy. Decommissioning by flotation in one piece is predicted to use the largest amount of energy. The differences are largely attributable to offshore vessel use.

Table 8.4: Murchison jacket – energy use during decommissioning

Decommissioning Aspect	Energy (GJ)	CO_2 (tonnes)	NO_x (tonnes)	SO_2 (tonnes)	CH_4 (tonnes)
Partial removal by cut and lift - Method A					
Manufacture of new components or materials required for decommissioning	8,750	661	1.23	1.23	1.93
Vessel and helicopter use	175,319	13,016	240.00	16.27	895.36
Onshore transportation	293	21	0.27	0.01	No data
Onshore deconstruction	14,938	No data	No data	No data	No data
Recycling	108,348	11,516	19.05	45.25	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	263,168	20,049	40.60	56.72	No data
Total	**570,816**	**45,263**	**301.15**	**119.48**	**897.29**
Partial removal by cut and lift - Method B					
Manufacture of new components or materials required for decommissioning	8,750	661	1.23	1.23	1.93
Vessel and helicopter use	158,458	11,764	216.92	14.71	789.74
Onshore transportation	293	21	0.27	0.01	No data
Onshore deconstruction	14,938	No data	No data	No data	No data
Recycling	108,348	11,516	19.05	45.25	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	263,168	20,049	40.60	56.72	No data
Total	**553,955**	**44,011**	**278.07**	**117.92**	**791.66**

Table 8.4 (continued): Murchison jacket – energy use during decommissioning

Decommissioning Aspect	Energy (GJ)	CO_2 (tonnes)	NO_x (tonnes)	SO_2 (tonnes)	CH_4 (tonnes)
Partial removal by cut and lift - Method C					
Manufacture of new components or materials required for decommissioning	8,750	661	1.23	1.23	1.93
Vessel and helicopter use	295,046	21,905	403.89	27.38	1,645.39
Onshore transportation	293	21	0.27	0.01	No data
Onshore deconstruction	14,938	No data	No data	No data	No data
Recycling	108,348	11,516	19.05	45.25	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	263,168	20,049	40.60	56.72	No data
Total	**690,543**	**54,152**	**465.04**	**130.59**	**1,647.32**
Partial removal by flotation					
Manufacture of new components or materials required for decommissioning	46,500	3,513	6.51	6.51	10.23
Vessel and helicopter use	729,023	54,127	997.97	67.66	4,364.04
Onshore transportation	293	21	0.27	0.01	No data
Onshore deconstruction	14,938	No data	No data	No data	No data
Recycling	108,348	11,516	19.05	45.25	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	263,168	20,049	40.60	56.72	No data
Total	**1,162,270**	**89,226**	**1,064.40**	**176.15**	**4,374.27**

8.2.6 Pipeline PL115

Table 8.5 shows the estimated energy use and atmospheric emissions during the recommended option of decommissioning of pipeline PL115 – burial of exposed section by rock-placement and removal of spools at Murchison and Dunlin A. The removal of debris within the 500 m zone and along the pipeline route is not included within the calculated energy use and atmospheric emissions.

Table 8.5: Predicted energy use and atmospheric emissions for decommissioning of PL115 – bury exposed sections only, remove spools and bury ends – by rock-placement

Decommissioning Aspect	Energy (GJ)	CO_2 (tonnes)	NO_x (tonnes)	SO_2 (tonnes)	CH_4 (tonnes)
Manufacture of new components or materials required for decommissioning	2,800	140	No data	No data	No data
Vessel and helicopter use	8,851	657	12.12	0.82	48.61
Onshore transportation	0	0	0	0	No data
Onshore deconstruction	0	No data	No data	No data	No data
Recycling	0	0	0	0	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	90,656	9,578	32.42	18.38	No data
Total	**102,307**	**10,375**	**44.54**	**19.20**	**48.61**

8.2.7 Bundles

Estimated energy use and atmospheric emissions during full removal of bundles PL123, PL124 and PL125 by cut and lift are detailed within Table 8.6.

Table 8.6: Bundles PL123, PL124 and PL125 – energy use and atmospheric emissions during decommissioning

Decommissioning Aspect	Energy (GJ)	CO_2 (t)	NO_x (t)	SO_2 (t)	CH_4 (t)
Manufacture of new components or materials required for decommissioning	0	0	No data	No data	No data
Vessel and helicopter use	58,144	4,317	79.59	5.40	358.22
Onshore transportation	13	1	0.01	0	No data
Onshore deconstruction	666	No data	No data	No data	No data
Recycling	5,218	556	0.93	2.20	No data
New manufacture to replace recyclable materials left in situ or taken to landfill	0	0	0	0	No data
Total	**64,041**	**4,874**	**80.53**	**7.60**	**358.22**

8.2.8 Subsea Wellhead

Table 8.7 details estimated energy use for full removal of the subsea wellheads. The operations are predicted to use approximately 19,000 GJ of energy - over 90% of this is attributed to vessel use.

Table 8.7: Energy use and atmospheric emissions for decommissioning of subsea wellheads by full removal

Decommissioning Aspect	Energy (GJ)	CO_2 (tonnes)	NO_x (tonnes)	SO_2 (tonnes)	CH_4 (tonnes)
Manufacture of new components or materials required for decommissioning	0	0	0	0	0
Vessel and helicopter use	17,717	1,315	24.254	1.6444	109.53
Onshore transportation	2	0.2	0.002	0.0001	No data
Onshore deconstruction	115	No data	No data	No data	No data
Recycling	900	96	0.160	0.3800	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	0	0	0	0	No data
Total	**18,734**	**1,411.2**	**24.416**	**2.0245**	**109.53**

8.2.9 Murchison and Dunlin A Spool pieces

Estimated energy use during decommissioning of the Murchison and Dunlin A spool pieces by full removal is detailed within Table 8.8. The operations are predicted to use approximately 9,000 GJ of energy - over 90% of which attributable to vessel use.

Table 8.8: Energy use and atmospheric emissions for decommissioning of Murchison and Dunlin A spoolpieces

Decommissioning Aspect	**Energy** (GJ)	**CO_2** (tonnes)	**NO_x** (tonnes)	**SO_2** (tonnes)	**CH_4** (tonnes)
Manufacture of new components or materials required for decommissioning	0	0	0	0	0
Vessel and helicopter use	8,408	624	11.511	0.78040	51.71
Onshore transportation	1.3	0.1	0.001	0.00003	No data
Onshore deconstruction	155	No data	No data	No data	No data
Recycling	529	56	0.094	0.22344	No data
New manufacture to replace recyclable materials left *in situ* or taken to landfill	76	66	0.411	0.00761	No data
Total	**9,169.3**	**746.1**	**12.017**	**1.01148**	**51.71**

8.3 Impacts on Sensitive Receptors

Gaseous emissions from the Murchison decommissioning activities include CO_2, CH_4, NO_x, SO_x and Volatile Organic Compounds (VOCs) and 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 (IPCC, 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.

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.

The exposed offshore conditions will promote the rapid dispersion and dilution of these emissions. Outside the immediate vicinity of the Murchison decommissioning activities, all released gases would only be present in low concentrations The Murchison Development is located approximately 240 km northeast of the nearest UK 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 Murchison. 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.

The atmospheric emissions from the Murchison decommissioning activities are therefore unlikely to have any effect on sensitive receptors.

8.4 Mitigation

Mitigation measures to minimise atmospheric emissions and energy consumption are detailed within Table 8.9.

Table 8.9 Mitigation Measures

Mitigation
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.

8.5 Residual, Cumulative and Transboundary Impacts

As the Murchison Facilities are located approximately 2 km from the UK/Norwegian median line, there is potential for transboundary transport of atmospheric contaminants. However, under these offshore conditions, the quantity of additional air emissions produced is unlikely to create any measurable transboundary impact.

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 emissions from the proposed decommissioning operations (155,796 tonnes CO_2) represent a reduction in CO_2 emissions when compared to the total CO_2 emissions generated by Murchison during normal operations in 2011 (198,510 tonnes; CNRI, 2012a), and represent 1% of the total annual CO_2 offshore emissions from the UKCS (16,393,119 tonnes CO_2, Oil and Gas UK (2012).

8.6 Conclusions

The CA identified recommended options for the decommissioning of the Murchison Facilities, the energy use and atmospheric emissions relating to these options are discussed within this section. Where alternative methods of decommissioning are available for each option, comparisons are drawn below of energy use and atmospheric emissions to inform the future decision making process:

- The topsides decommissioning option expected to require the largest energy use (and, consequently, atmospheric emissions) is piece-small deconstruction.
- The jacket decommissioning options expected to require the most energy would be partial removal by flotation. The energy use for other options is too similar to allow separation on the basis of energy use.

The following conclusions from the quantification and impact assessment are made:

- 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 project 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.
- Emissions from the decommissioning activities will contribute to greenhouse gas emissions and have a non-significant cumulative and transboundary impact. Emissions will be kept to a practicable minimum. Total CO_2 emissions generated from the proposed decommissioning operations will be lower than CO_2 emissions generated by normal operations at Murchison.

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9.0 UNDERWATER NOISE

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), for example, use sound for navigation, communication and prey detection. Anthropogenic underwater noise has the potential therefore to impact on marine mammals (Southall *et al*., 2007, Richardson *et al*., 1995). For example, underwater noise may cause animals to become displaced from activities potentially interrupting feeding, mating, socialising, resting or migration. This may affect 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; Vella *et al*., 2001).

Several activities associated with the Murchison Facilities decommissioning will generate underwater noise. This section assesses the potential noise impacts associated with these activities on target species.

9.1 Methodology

CNRI commissioned a noise impact assessment to predict sound levels and potential impacts of underwater noise likely to be generated during the proposed Murchison Field decommissioning (BMT Cordah, 2012d). The impact assessment considered all decommissioning options for all Murchison Facilities to inform the CA (Section 4). This section presents the findings of the noise impact assessment for the recommended option only.

Such an assessment is required to assess the likelihood of causing injury or disturbance to marine mammals as a result of underwater noise (JNCC, 2010). Under regulations 41(1)(a) and (b) of the Conservation (Natural Habitats &c.) Regulations 1994 (as amended) and 39(1)(a) and (b) of the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (amended 2009 and 2010), it is an offence to (a) deliberately capture, injure or kill any wild animal of a European Protected Species (EPS); and (b) deliberately disturb wild animals of any such species. EPS includes all species of cetacean (JNCC, 2010).

The following steps were undertaken to assess the likely environmental impact of underwater noise potentially generated during the Murchison decommissioning (BMT Cordah, 2012d):

- Identification of sources of sound likely to result from each decommissioning activity.
- Characterisation of these sound sources, in terms of typical source levels, frequencies and duration.
- Estimation of the likely resulting acoustic field during each decommissioning activity.
- Sound propagation modelling from the source into the surrounding marine environment.
- Identification of marine mammal species likely to occur in the Murchison area and their hearing characteristics.

- Application of the JNCC (2010) recommended method for assessing the likelihood of causing injury or disturbance to marine mammals as a result of underwater noise.

9.1.1 Modelling of Sound Sources and Propagation

The sources of sound associated with each activity were summed to provide a total sound level. To consider the worst case scenario, the model assumed all sources operated at all times during each activity. In reality, there is likely to be much fluctuation in the acoustic field as, for example, some vessels may be present only intermittently and some operations may be conducted sequentially rather than simultaneously. The actual source level may therefore be lower than predicted.

The propagation of sound from the source for each activity has been modelled using modified underwater sound transmission equations initially described by Richardson *et al.* (1995), neglecting absorption, scattering and reverberation (BMT Cordah, 2012d).

9.1.2 Precautionary Criteria for Injury or Disturbance to Marine Mammals

Southall *et al*. (2007) reviewed the impacts of underwater noise on marine mammals and defined criteria for predicting sound levels likely to cause injury or a severe behavioural response in marine mammals with different hearing characteristics (“low”, “mid” and “high frequency” hearing) subjected to different types of sound (“pulse”, “multiple pulse” and “non-pulse”). These criteria, which are now widely recognised within the scientific community as the appropriate precautionary noise criteria for assessing the impact of underwater noise on marine mammals (JNCC, 2010), are applied here to the potential sound generated by the Murchison decommissioning.

The Southall *et al*. (2007) precautionary criteria for injury and disturbance to marine mammals is detailed within Table 9.1. It can be assumed that the exposure of an animal to sound above these levels is likely to lead to injury or disturbance, respectively.

Additionally, Southall *et al*. (2007) highlighted the single-pulse data of Lucke *et al*. (2007), indicating harbour porpoise may have lower thresholds for injury, with the onset of a temporary shift in hearing thresholds (Temporary Threshold Shift, TTS-onset) observed at a received sound pressure of 200 dB peak-peak re 1 μPa (equivalent to 194 dB peak) and sound exposure level of 164 dB re 1 $\mu Pa^2 s$. As suggested by JNCC (2010), these lower thresholds for TTS could be used to estimate Permanent Threshold shift (PTS) and used as a more precautionary injury threshold for these animals. Therefore, the peak level injury criterion of 200 dB is determined by applying the PTS onset calculation described by Southall *et al*. (2007) (i.e. by adding +6 dB to the peak level for TTS).

Table 9.1: Sound levels likely to lead to injury or a behavioural response in individual marine mammals exposed to different sound types

Functional hearing group	Sound measure[1]	Injury threshold for different sound types			Disturbance threshold for single pulse sounds[2]		
		Single pulse	Multiple pulse	Non-pulse	Single pulse	Multiple pulse	Non-pulse
Low-frequency cetacean	SPL	230	230	230	224	-	-
	SEL	198	198	215	183	-	-
Mid-frequency cetacean	SPL	230	230	230	224	-	-
	SEL	198	198	215	183	-	-
High-frequency cetacean	SPL	230[3]	230	230	224	-	-
	SEL	198	198	215	183	-	-
Pinniped (in water)	SPL	218	218	218	212	-	-
	SEL	186	186	203	171	-	-
Pinniped (in air)	SPL	149	149	149	109	-	-
	SEL	144	144	144.5	100	-	-

Notes:
1. SPL – peak Sound Pressure Level in dB re 1 µPa; SEL – weighted Sound Exposure Level in dB re 1 µPa^{2}s.
2. Southall *et al*. (2007) did not define thresholds for disturbance from multiple pulse and non-pulse sounds.
3. The peak level injury criterion of 200 dB is determined for harbour porpoise.

For multiple pulse and non-pulse sounds, Southall *et al.* (2007) concluded that the available data on marine mammal behavioural response were too variable and context-specific to justify proposing single disturbance criteria for broad categories of taxa and sounds. Instead, Southall *et al.* (2007) reviewed available observations on behavioural responses of each marine mammal functional hearing group to different types of sound and ranked the reported responses according to a “behavioural response severity” scale where:

- a score of 0 to 3 is given to behaviour that is relatively minor or brief;
- a score of 4 to 6 is given to behaviour with a higher potential to affect foraging, reproduction or survival rates; and
- a score of 7 to 9 is given to behaviour considered likely to affect foraging, reproduction or survival rates.

Southall *et al.* (2007) recommend assessing whether sound from a specific source could cause disturbance to a particular species by comparing the circumstances of the situation with empirical studies reporting similar circumstances. JNCC (2010), in their guidance on how to assess and manage the risk of causing “injury” or “disturbance” to a marine EPS as a result of activities at sea, suggest that disturbance to a marine mammal is likely to occur from sustained or chronic behavioural response with a severity scoring of 5 or above according to the scale of Southall *et al*. (2007).

Following this approach, received sound levels from the Murchison decommissioning that may cause a severe behavioural response have been determined using noise studies reviewed in Southall *et al*. (2007) that:

- are relevant to the Murchison decommissioning, reporting on similar noise sound sources and similar species; and
- report to a behavioural response of severity 5 or above.

These sound thresholds are compared with the modelled sound levels generated by the decommissioning activities to estimate a distance from the activities within which disturbance may occur.

9.1.3 Evaluation of Potential Impacts

The likely impact of noise generated by the proposed decommissioning activities on cetaceans occurring in the Murchison area was then assessed by comparing the received noise levels with the Southall *et al.* (2007) criteria for injury and disturbance to marine mammals, according to the recommended method of JNCC (2010).

9.2 Potential Sources and Magnitude of Impact

The predominant sources of sound associated with the proposed Murchison decommissioning activities include:

- Use of vessels for transportation and to carry out decommissioning operations.
- Helicopters for transportation of personnel.
- Use of underwater tools for cutting and drilling.
- Side-scan sonar to carry out surveys.
- Trenching, water jetting, dredging and rock-placement.

The typical characteristics of sound produced by different activity and vessels and the mean level of background sound are summarised within Table 9.2.

The classification of these sources according to the sound types used by Southall et al. (2007) is shown in Table 9.3. Although, in practice, the distinction between different sound types is not always clear, the sound from the majority of activities associated with the Murchison decommissioning would be classed as “non-pulse”. Sound generated by side-scan sonar would be classed as “multiple pulse”.

Table 9.2: Characteristics of underwater sound produced by different vessels and activity

Source	Approximate source level of underwater sound (dB re 1µPa at 1m)	Predominant frequencies (Hz)
Dredging/trenching/water jetting	177	80 to 200
Rock-placement	< 180	< 1000
Tug vessel towing barge	140 to 170	100 to 500
Supply/support vessel	160 to 180	50 to 200
Dynamic positioning vessel	170 to 180	500 to 1,000
Small vessels (55 to 85 m)	170 to 180	< 1,000
Helicopters	109 *	< 500
In air cutting	Unknown	Unknown
Underwater cutting	200 **	Unknown
Use of underwater tools (general)	148 to 180	200 to 1,000
Side-scan sonar	220 to 230	50,000 to 500,000
Mean ambient level in the open ocean	80 to 100	-
Contribution of general shipping traffic to background noise levels in the ocean	–	20 – 300

Key: dB re1 µPa at 1 m – unit of Sound Pressure Level extrapolated to 1m range from source.
* Received level at 3 to 18 m below the sea surface.
** Estimated value from general tool use and previous decommissioning noise assessments.

Source: Genesis (2011); Nedwell and Edwards (2004); Richardson et al. (1995); Wenz (1962)

Table 9.3: Sound generating activities associated with the Murchison decommissioning under the sound categories described by Southall *et al*. (2007)

Sound type	Definition *	Murchison decommissioning activities
Single pulse	Brief, broadband, atonal, transient, single discrete acoustic events, characterised by rapid rise to peak pressure.	No single pulse sources currently planned e.g. explosives
Multiple pulse	Multiple pulse events within 24 hours.	Side-scan sonar
Non-pulse	Intermittent or continuous, single or multiple discrete acoustic events within 24 hours; tonal or atonal and without rapid rise to peak pressure.	Vessels, helicopters, trenching/water jetting, rock-placement, underwater cutting, general underwater tool use

* Empirical definition from Southall *et al*. (2007)

The main sources of sound associated with the recommended decommissioning options, as described within Section 4, are summarised in Table 9.4.

Topsides Decommissioning

The Murchison topsides will be fully removed, either by reverse installation or piece-small offshore deconstruction. Both decommissioning options are being considered at this stage of the project, and are therefore assessed within this ES.

For reverse installation, modules would be separated by deconstruction of the module interfaces and then removed individually by a dedicated vessel. The modules would be back-loaded to the deck of the vessel or to a cargo barge and then transported to shore. The main source of underwater sound for these activities will be vessels. Sound will also be generated by cutting tools used to separate the topsides models but it has been assumed that propagation of this sound into the water will be limited and not make a significant contribution to the underwater sound field.

For piece-small deconstruction, modules and other facilities on the topside would be dismantled offshore using manual hot and cold cutting techniques to break the facilities into small manageable sections, which would then be loaded into containers for transportation to shore on supply vessels. Again, it is assumed that underwater sound generated by use of cutting tools in air will be limited. The offshore operations would take approximately 750 days (Table 9.4).

9.2.1 Predicted Sound Levels Generated During Decommissioning

The following section below presents the predicted sound propagation results for the recommended decommissioning options (BMT Cordah, 2012d).

Topsides Activities Post CoP

After CoP, various activities must be conducted on the Murchison Platform to prepare the platform for decommissioning and the removal of the topsides modules. These activities include EDC of the topsides modules and equipment and preparation of topsides for removal. The period over which these activities will be conducted is expected to be approximately 29 months (870 days) (CNRI, 2011c; Table 9.4).

During these activities, underwater sound will be generated by the support and supply vessels used to service the Murchison Platform and helicopters used to transport personnel. Sound levels are likely to fluctuate over this period depending on which vessels are present.

The completion of well P&A and conductor recovery will also be undertaken from the platform post CoP. Well P&A is expected to take 15 months (450 days) and conductor recovery a further 7 months (210 days) (CNRI, 2011c; Table 9.4).

Table 9.4: Summary of Murchison decommissioning activities and main sound sources

Section	Decommissioning method		Approx. duration (days)	Predominant sound sources	
	Option	Sub-option		Vessels	Other
Topsides activities post CoP	EDC	N/A	870	Supply vessel, standby vessel,	Helicopters
P&A and conductor recovery	N/A	N/A	660	Supply vessel, ROV launched from the platform	Sub-seabed cutting of conductors, high pressure jet cleaning
Topsides	Full removal	Reverse installation – Method A	150	HLV, cargo barge, two AHVs, supply vessel, standby vessel	Cutting (in air)
		Reverse installation – Method B	150	HLV, cargo barge, two tugs, CSV, standby vessel, supply vessel	Cutting (in air)
		Reverse installation – Method C (over one season or two seasons)	280	HLV, supply vessel, standby vessel, tug	Cutting (in air)
		Piece-small	750	HLV, waste carrier, standby vessel, supply vessel, flotel, two tugs	Helicopters, cutting (in air)
Jacket	Partial removal	Cut and lift – Method A	70	HLV, CSV, standby vessel	Cutting (underwater) of jacket. Other tool use.
		Cut and lift – Method B	120	ROVSV, CSV, HLV, standby vessel	Cutting (underwater) of jacket. Other tool use.
		Cut and lift – Method C	70	HLV, CSV, two cargo barges, two tugs, standby vessel	Cutting (underwater) of jacket. Other tool use.
		Flotation in one piece	925	Survey vessel, three tractor tugs, two operational support vessels, crane barge, standby vessel, one inshore tug	Cutting (underwater) of jacket. Tool use for inshore deconstruction.

Table 9.4 (continued): Summary of Murchison decommissioning activities and main sound sources

Section	Decommissioning method		Approx. duration (days)	Predominant sound sources	
	Option	Sub-option		Vessels	Other
Pipelines	Burial by rock-placement	Bury exposed sections by rockdump; remove tie-in spools and mattresses; leave rock-placement *in situ*	7	Rock-placement vessel, DSV	Mass flow excavation (MFE) (water jetting)
Bundles	Full removal	Recover in sections	83	ROVSV, tug, barge,	Cutting, drilling lift holes
Wellheads	Full removal	N/A	3.5	DSV, tug, barge	-
Murchison and Dunlin A platform approaches	Removal of Murchison and Dunlin A spoolpieces	N/A	11	ROV, DSV	-
Surveys	Pre-decommissioning inspection, debris surveys and post-decommissioning surveys	N/A	Various	ROVSV, Remotely operated towed vessel (ROTV)	Side scan sonar
Drill cuttings pile	Leave *in situ*	N/A	N/A	N/A	N/A

Source: CNRI (2011c, 2011e); Atkins (2011)

During these activities, underwater sound will be generated by the supply vessel that will be used to transport the material recovered during wells P&A and conductor recovery and by the equipment used to cut the conductors ten feet below the seabed using a mechanical or abrasive cutter. This sub-seabed cutting will be carried out using a mechanical or abrasive cutter and is not expected to generate significant underwater noise (G. Skelly; personal communication). Once on the platform, the conductors will be cleaned using a high pressure jet cleaner; although generating high sound levels in air, this activity is unlikely to generate any additional underwater sound. Therefore, it is expected that the only significant source of underwater sound associated with these activities will be the supply vessel. The estimated source and propagated sound levels are given in Table 9.5, assuming the following sound sources:

- EDC and servicing: helicopters (source peak pressure level up to 109 dB re 1 µPa at 1 m), a supply vessel (up to 180 dB re 1 µPa at 1 m) and a support vessel (up to 180 dB re 1 µPa at 1 m).
- Wells P&A and conductor recovery: supply vessel (up to 180 dB re 1 µPa at 1 m).

Table 9.5: Estimated received underwater sound levels during topsides activities post cessation of production

Activity	Source SPL of activity (dB re 1 µPa at 1 m)	Received SPL (dB re 1 µPa) at distance (km) from source								
		0.1	0.5	1	2	5	10	25	50	100
EDC and servicing of platform post CoP	183	143	132	127	123	117	112	108	102	97
Wells P&A and conductor recovery	180	140	129	124	120	114	109	105	99	94

The estimated source and propagated sound levels associated with each option are given in Table 9.6, where the following noise sound have been assumed (Table 9.4) and the cumulative sound level estimated:

- Reverse installation Method A: HLV (up to 180 dB re 1 µPa at 1 m), two AHVs pulling a cargo barge (up to 170 dB re 1 µPa at 1 m each), a standby vessel (180 dB re 1 µPa at 1 m) and a supply vessel (180 dB re 1 µPa at 1 m).
- Reverse installation Method B: HLV (up to 180 dB re 1 µPa at 1 m), two tugs pulling a cargo barge (up to 170 dB re 1 µPa at 1 m each), a CSV (up to 180 dB re 1 µPa at 1 m), a standby vessel (180 dB re 1 µPa at 1 m) and a supply vessel (180 dB re 1 µPa at 1 m).
- Reverse installation Method C: HLV (up to 180 dB re 1 µPa at 1 m), tug vessel (up to 170 dB re 1 µPa at 1 m), a standby vessel (180 dB re 1 µPa at 1 m) and a supply vessel (180 dB re 1 µPa at 1 m).
- Piece-small: HLV (up to 180 dB re 1 µPa at 1 m), waste carrier (up to 180 dB re 1 µPa at 1 m), a standby vessel (180 dB re 1 µPa at 1 m), two tugs (up to 170 dB re 1 µPa at 1 m each, flotel (180 dB re 1 µPa at 1 m) and a supply vessel (180 dB re 1 µPa at 1 m).

Table 9.6 Estimated received underwater sound levels during topsides decommissioning

Decommissioning activity	Source SPL	Received SPL (dB re 1 µPa) at distance (km) from source								
Full removal - sub-option	(dB re 1 µPa at 1 m)	0.1	0.5	1	2	5	10	25	50	100
Reverse installation Method A	185	145	133	129	124	118	114	109	103	99
Reverse installation Method B	186	146	135	130	126	120	115	111	105	100
Reverse installation Method C	185	145	133	129	124	118	114	109	103	99
Piece-small	186	146	135	130	126	120	115	111	105	100

Jacket Decommissioning

The recommended decommissioning option for the Murchison jacket is by partial removal, with the jacket cut down to the footings. The upper part of the jacket would be removed by either it cutting into sections and lifting it onto an HLV for transfer to shore or flotation of the whole jacket in one piece using buoyancy tanks. The recovered jacket material would be returned to shore whilst the remaining footings would be left in place. Again, sub-options exist for partial removal by cut and lift, referred to as Methods A, B and C. Methods A and C are anticipated to require 70 days for completion and Method B 120 days. Partial removal by flotation would take approximately 925 days. The estimated source and propagated sound levels associated with each jacket decommissioning option are given in Table 9.7, where the following sound sources have been assumed (Table 9.4) and the cumulative sound level estimated:

- Partial removal by cut and lift Method A: HLV (180 dB re 1 µPa at 1 m), CSV (180 dB re 1 µPa at 1 m), standby vessel (180 dB re 1 µPa at 1 m) and underwater cutting (up to 200 dB re 1 µPa at 1 m).

- Partial removal by cut and lift Method B: HLV (180 dB re 1 µPa at 1 m), CSV (180 dB re 1 µPa at 1 m), ROVSV (180 dB re 1 µPa at 1 m), standby vessel (180 dB re 1 µPa at 1 m) and underwater cutting (up to 200 dB re 1 µPa at 1 m).

- Partial removal by cut and lift Method C: HLV (180 dB re 1 µPa at 1 m), CSV (180 dB re 1 µPa at 1 m), two tugs pulling cargo barges (170 dB re 1 µPa at 1 m), standby vessel (180 dB re 1 µPa at 1 m) and underwater cutting (up to 200 dB re 1 µPa at 1 m).

- Partial removal by flotation in one piece: survey vessel (180 dB re 1 µPa at 1 m), three tractor tugs (170 dB re 1 µPa at 1 m each), two operational support vessels (180 dB re 1 µPa at 1 m each), crane barge (180 dB re 1 µPa at 1 m), standby vessel (180 dB re 1 µPa at 1), inshore tug (170 dB re 1 µPa at 1 m) and underwater cutting (up to 200 dB re 1 µPa at 1 m).

- Underwater cutting is expected to be the highest source of sound associated with the jacket decommissioning, although there are no published measurements of this type of sound. However, the cutting operations are expected to be short in duration, lasting a few hours each over a period of days to weeks. For the majority of the time, vessels will be the main sources of sound. Therefore, Table 9.7 and subsequent tables present the expected sound levels during and outwith cutting operations.

Table 9.7: Estimated received sound levels during jacket decommissioning

Decommissioning activity		Source SPL (dB re 1 µPa at 1 m)	Received SPL (dB re 1 µPa) at distance (km) from source								
			0.1	0.5	1	2	5	10	25	50	100
Outwith cutting operations											
Partial removal	Cut & lift Method A	185	145	134	129	125	119	114	110	104	99
	Cut & lift Method B	186	146	135	130	126	120	115	111	105	100
	Cut & lift Method C	185	145	134	129	125	119	114	110	104	99
	Flotation	186	146	135	130	126	120	115	111	105	100
During cutting operations (applied to all options/sub-options)											
Cutting		200	160	149	144	140	134	129	125	119	114

Pipeline and Subsea Infrastructure

The recommended option for pipeline removal is to bury exposed sections by rock-placement and remove tie-in spools and mattresses. The main sources of sound associated with this work will be vessels and rock-placement. The estimated sound source and received levels for each option are given in Table 9.8, with the following assumed sound sources:

- DSV (180 dB re 1 µPa at 1 m) and rock-placement vessel (up to 180 dB re1 µPa at 1 m).

Table 9.8: Estimated received sound levels during pipeline decommissioning

Decommissioning activity		Source SPL (dB re 1 µPa at 1 m)	Received SPL (dB re 1 µPa) at distance (km) from source								
			0.1	0.5	1	2	5	10	25	50	100
Outwith cutting operations											
Burial by rock-placement	Bury exposed sections, remove tie-in, spools and mattresses	183	143	132	127	123	117	112	108	102	97

Bundles

The three bundles will be fully removed, by cutting and lifting in sections. The bundles will be cut into sections on the seabed before being lifted onto the vessel. Removal operations are expected to take approximately 83 days including two weeks of underwater cutting. The estimated sound source and received levels for the recommended option is provided within Table 9.9, with the following assumed sound sources:

- ROVSV (180 dB re 1 µPa at 1 m) and tug pulling barge (up to 170 dB re1 µPa at 1 m), plus underwater cutting (200 dB re1 µPa at 1 m).

Table 9.9: Estimated received sound levels during bundles decommissioning

Decommissioning activity	Source SPL (dB re 1 µPa-m)	Received SPL (dB re 1 µPa) at distance (km) from source								
Option		0.1	0.5	1	2	5	10	20	50	100
Outwith cutting operations										
Recover in sections	180	140	129	124	120	114	109	105	99	94
During cutting operations										
Cutting	200	160	149	144	140	134	129	125	119	114

Subsea Wellhead

The wellheads and guide bases for the three abandoned Murchison subsea tie-back wells will be fully removed, which is estimated to take 3.5 days for completion. The estimated source and propagated sound levels during the wellheads decommissioning are provided within Table 9.10, with the following assumed sound sources:

- DSV (180 dB re 1 µPa at 1 m) and tug pulling barge (170 dB re 1 µPa at 1 m).

Table 9.10: Estimated received sound levels during wellheads decommissioning

Decommissioning activity	Source SPL (dB re 1 µPa at 1 m)	Received SPL (dB re 1 µPa) at distance (km) from source								
		0.1	0.5	1	2	5	10	25	50	100
Full removal	180	140	129	124	120	114	109	105	99	94

Murchison and Dunlin A Spoolpieces

The Murchison and Dunlin A spoolpieces will each be removed by cutting and lifting off the seabed using an ROVSV and cutting tool and a DSV. This is expected to take approximately 11 days, with two days of cutting. The estimated source and propagated sound levels from the sound sources associated with removal of the spoolpieces are provided in Table 9.11, where the following sound sources have been assumed (Table 9.4) and the cumulative sound level has been estimated as described in Section 9.1:

- Spoolpiece removal: DSV (180 dB re1 µPa at 1 m), ROVSV (180 dB re1 µPa at 1 m) and underwater cutting (200 dB re1 µPa at 1 m).

Table 9.11: Estimated received sound levels during Murchison and Dunlin A platform approaches decommissioning

Decommissioning activity	Source SPL (dB re 1 µPa at 1 m)	Received SPL (dB re 1 µPa) at distance (km) from source								
		0.1	0.5	1	2	5	10	25	50	100
Outwith cutting operations										
Spoolpiece removal - Dunlin A	183	143	132	127	123	117	112	108	102	97
Spoolpiece removal - Murchison	183	143	132	127	123	117	112	108	102	97
During cutting operations (Dunlin A and Murchison spoolpiece removal; recovery of umbilical in sections)										
Cutting	200	160	149	144	140	134	129	125	119	114

Surveys

Various inspection surveys will be carried out as part of the Murchison decommissioning, including pre-work surveys, as-left surveys and post-decommissioning surveys. The estimated sound levels associated with this activity are shown in Table 9.12, where each vessel has been assumed to generate peak source levels up to 180 dB re 1 µPa at 1 m.

Table 9.12: Estimated received sound levels during surveys

Decommissioning activity	Source SPL (dB re 1 µPa at 1 m)	Received SPL (dB re 1 µPa) at distance (km) from source								
		0.1	0.5	1	2	5	10	20	50	100
Surveys	183	143	132	127	123	117	112	108	102	97

9.3 Impacts on Sensitive Receptors

As discussed within Section 5, the main marine mammal species occurring in the Murchison area are minke whale, long-finned pilot whale, killer whale, white-beaked dolphin, white-sided dolphin and harbour porpoise, with most sightings occurring in the summer months (Reid *et al*., 2003; UKDMAP, 1998). In addition, sperm whales have occasionally been sighted in the vicinity of Block 211 between May and October (UKDMAP, 1998). The hearing characteristics of these species according to the classification system of Southall et al. (2007) are shown in Table 9.13. As the Murchison Field is 150 km from the nearest coastline, it is unlikely that significant numbers of grey or harbour seals would be found in the vicinity of the field. This assessment, therefore, focuses on cetaceans.

Presence and abundance of cetacean species in the Murchison area varies through the year (Reid *et al*., 2003; Hammond *et al*., 2001; UKDMAP, 1998). In order to make a worst-case assessment, this assessment assumes that the Murchison decommissioning activities could occur at any time of year.

Table 9.13: Functional cetacean hearing group of species likely to occur in the Murchison Facilities area

Cetacean functional hearing group	**Estimated auditory bandwidth**	**Species sighted in the Murchison Facilities area** (Quadrant 211 and surrounding quadrants)
Low-frequency	7 Hz – 22 kHz	Minke whale
Mid-frequency	150 Hz – 160 kHz	Long-finned pilot whale Killer whale White-beaked dolphin White-sided dolphin Sperm whale
High-frequency	200 Hz – 180 kHz	Harbour porpoise

Sources: Southall *et al*. (2007); UKDMAP (1998)

9.3.1 Injury to Cetaceans

For each Murchison decommissioning activity, Table 9.13 indicates the distance from the operations beyond which the predicted sound level would be too low for injury to cetaceans according to the Southall *et al*. (2007) criteria, i.e. the peak sound pressure level would be lower than 230 dB re 1 µPa. For each aspect of decommissioning, the highest predicted sound field over all options has been used. As detailed within Table 9.14, the threshold for injury is not exceeded by any of the proposed activities.

Table 9.14: Predicted sound level at source for each decommissioning activity and the distance within which injury to cetaceans is predicted

Decommissioning activity	**Maximum source SPL** (dB re 1 µPa at 1 m)	**Distance to 230 dB re 1 µPa,** the sound pressure threshold for injury
Murchison topsides activities post CoP	183	Threshold never exceeded
Topsides decommissioning	186	Threshold never exceeded
Jacket decommissioning	200	Threshold never exceeded
Pipelines decommissioning	183	Threshold never exceeded
Platform approaches decommissioning	200	Threshold never exceeded
Wellheads decommissioning	183	Threshold never exceeded
Surveys	183	Threshold never exceeded

Source: Southall *et al*. (2007)

9.3.2 Disturbance to Cetaceans

Single-pulse sounds

Table 9.15 indicates the distance from the recommended decommissioning options beyond which the predicted sound level would be too low for a behavioural response in cetaceans according to the Southall *et al*. (2007) criteria for single pulse sounds, i.e. the peak sound pressure level would be lower than 224 dB re 1 µPa. As detailed within Table 9.14, the threshold for disturbance from a single pulse sound is not exceeded by any of the proposed activities.

Based on the findings of Lucke *et al*. (2007), JNCC (2010) suggest lower thresholds for TTS could be used to estimate PTS and subsequently used as a more precautionary injury threshold for harbour porpoise. Following Southall *et al*. (2007), the peak level injury criterion of 200 dB is determined by applying the PTS onset calculation. The threshold is exceeded only during cutting activities, to a distance of 0.19 m from source.

Additionally, in reality, it is unlikely that any of the sound generated by the Murchison decommissioning would be characterised as "single pulse".

Table 9.15: Predicted sound level at source for each decommissioning activity and distance from source within which disturbance to cetaceans from single-pulse sounds is predicted

Decommissioning activity	**Maximum source SPL** (dB re 1 µPa at 1 m)	**Distance to 224 dB re 1 µPa** (the sound pressure threshold for disturbance from single-pulse sound sources)
Murchison topsides activities post CoP	183	Threshold never exceeded
Topsides decommissioning	186	Threshold never exceeded
Jacket decommissioning	200	Threshold never exceeded
Pipelines decommissioning	183	Threshold never exceeded
Umbilical decommissioning	200	Threshold never exceeded
Platform approaches decommissioning	200	Threshold never exceeded
Wellheads decommissioning	183	Threshold never exceeded
Surveys	183	Threshold never exceeded

Source: Southall *et al*. (2007)

Multiple pulse and non-pulse sounds

Following the JNCC recommended method (Section 9.1), the noise studies reviewed by Southall *et al*. (2007) were, where possible, used to determine received sound levels from the Murchison decommissioning that may cause a severe behavioural response (Table 9.16).

These sound thresholds have been compared with the sound levels and sound types generated by the activities associated with the Murchison decommissioning to estimate a distance from the activities within which a severe behavioural response may occur for each cetacean hearing type (Table 9.16). The results for the activities involving underwater cutting are grouped together for ease of presentation. The area has then been multiplied by an estimate of the density of animals in the area, based on the SCANS II July 2005 survey (SCANS II, 2010) to estimate the number of animals of each species potentially experiencing behavioural disturbance of severity 5 or above (Table 9.17).

Table 9.16: Estimated distance within which behavioural disturbance to cetaceans may occur

Functional hearing group	Sound type	SPL (dB re 1 µPa) potentially causing disturbance	Distance (m) within which received SPL is higher than SPL potentially causing disturbance (to 3 significant figures)				
			Topsides activities post CoP	Topsides decommissioning	Jacket, pipeline & platform approaches decommissioning (During cutting)	Wellheads decommissioning	Surveys
Low-frequency cetaceans	Multiple pulse	~ 140 – 160 dB	N/A	N/A	N/A	N/A	N/A
	Non-pulse	~ 120 – 160 dB	2,950	4,830	41,100	1,850	1,850
Mid-frequency cetaceans	Multiple pulse	No clear relationship between received SPL and response severity.	N/A	N/A	N/A	N/A	N/A
	Non-pulse	> ~ 120 dB	2,950	4,830	41,100	1,850	1,850
High-frequency cetaceans	Multiple pulse	ND	N/A	N/A	N/A	N/A	N/A
	Non-pulse	Strong response at > ~ 140 dB	137	224	1,900	86.0	86.0

N/A (not applicable) – sound type is not applicable to this activity;

ND (No Data) – lack of data in the scientific literature;

Received SPL thresholds have been estimated from results of studies reviewed by Southall *et al*. (2007) considered relevant to the Murchison decommissioning activities (similar species and sound sources) and causing behavioural response of severity 5 or greater (JNCC, 2010).

Table 9.17: Estimated number of animals likely to experience sound sufficient to cause behavioural disturbance

Species	Estimated density (animals/ km^2) *	Estimated number of animals that may experience disturbance (to 3 significant figures)				
		Topsides activities post CoP	Topsides decommissioning	Jacket, pipeline, umbilical,& platform approaches decommissioning (During cutting)	Wellheads decommissioning	Surveys
Minke whale	0.013	0.35	0.95	68.9	0.14	0.14
Long finned pilot whale	ND	ND	ND	ND	ND	ND
Killer whale	ND	ND	ND	ND	ND	ND
White-beaked dolphin	0.011	0.30	0.81	58.4	0.10	0.10
White-sided dolphin	0.094	2.57	6.90	499	1.02	1.02
Harbour porpoise	0.177	0.01	0.03	2.02	0.004	0.004
Sperm whale	ND	ND	ND	ND	ND	ND

* Source: SCANS II survey (SCANS II, 2010)
ND (No Data) indicates lack of data in the scientific literature.

9.4 Mitigation

The activities associated with the Murchison Facilities decommissioning are expected to have a negligible impact on cetaceans in the area. The types of operation, including rock-placement, vessel activity, and side-scan sonar, are in general not considered likely by JNCC (2010) to pose a high risk of injury or non-trivial disturbance. The noise impact assessment supports this view, concluding that there is unlikely to be any significant impact on any marine species (BMT Cordah, 2012d). Hence, it is considered unlikely that any specific mitigation measures would be required. However, the following mitigation measures, will be in place demonstrating best environmental practice:

- During decommissioning operations, regular observations for marine mammals in the area will be made and the cetacean observation logs made available to JNCC.
- Offshore vessels will avoid concentrations of marine mammals and maintain a steady course and speed when possible.
- The operation of well-maintained equipment during the decommissioning activities will ensure that the noise of operating machinery is kept as low as possible during the decommissioning operations.
- The number of vessels travelling to or standing by Murchison will be kept to the minimum.
- A minimum operational altitude will be set for helicopter transits and approaches.

9.5 Residual, Cumulative and Transboundary Impacts

For safety purposes, activities as described within this assessment will occur sequentially and not simultaneously thereby minimising cumulative noise impacts. Noise generated during the decommissioning activities will contribute to the ambient noise already generated by vessels, shipping and construction in the area. Ambient noise is defined as background noise without distinguishable sound sources, including natural (biological and physical) and anthropogenic sounds (Tasker *et al*., 2010). There are concerns that ambient noise levels have increased in recent decades, mainly due to shipping activity, which may result in the masking of communication calls in marine mammals. Under the Marine Strategy Framework Directive (MSFD), work is currently underway to develop methods to monitor and report on levels of ambient underwater noise (Tasker *et al*., 2010). The contribution to ambient noise levels from the decommissioning activities will be of short duration and will be minimised by the mitigation measures outlined in Section 9.4.

The Murchison Facilties are adjacent to, and the Murchison Platform is approximately 2 km from, the UK/Norway median line. This assessment predicts that the Southall *et al*. (2007) thresholds for disturbance may be exceeded up to 41 km from the operations during cutting and up to 4.8 km during other operations. Therefore, it is predicted that the zone of potential disturbance may extend into Norwegian waters at times during the Murchison decommissioning operations. However, the operations are expected to be short in duration with, for example, periods of underwater cutting occurring for a few hours each over a period of days to weeks (Table 9.4).

9.6 Conclusions

The main marine mammal species occurring in the Murchison area are minke whale, long-finned pilot whale, killer whale, white-beaked dolphin, white-sided dolphin and harbour porpoise, with most sightings occurring in the summer months (Reid *et al*., 2003; UKDMAP, 1998). In addition, sperm whales have occasionally been sighted in the vicinity of Block 211 between May and October (UKDMAP, 1998). As the Murchison Field is 150 km from the nearest coastline, it is unlikely that significant numbers of grey or harbour seals would be found in the vicinity of the field.

The threshold for injury, 230 dB re 1 μPa at 1 m as defined by Southall *et al*. (2007), is not exceeded by any of the proposed decommissioning activities.

Underwater cutting is expected to be the highest source of sound associated with the decommissioning activities with thresholds for disturbance potentially exceeded up to 41 km from source. However, the cutting operations are expected to be short in duration, lasting a few hours each over a period of days to weeks.

The use of explosives to cut jacket members or any of the associated subsea equipment is not anticipated.

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10.0 SEABED DISTURBANCE

This section discusses potential short and long-term environmental impacts associated with seabed disturbance during the decommissioning of the Murchison Facilities. The measures taken or planned by CNRI to minimise these impacts are detailed in Section 10.4.

10.1 Methodology

This assessment is supported by the following studies commissioned by CNRI to assess the impacts associated with seabed disturbance, including drill cuttings disturbance, resulting from potential decommissioning activities:

- Murchison Drill Cuttings Pile Modelling the Effects of Human Disturbance of the Cuttings Pile Report (Genesis, 2013a).
- Murchison Drill Cuttings Pile Long-Term Cuttings Pile Characteristics Report (Genesis, 2013b).
- Murchison Drill Cuttings Pile Modelling Disturbance of Drill Cuttings from the Collapse of the Structural Piles Report (Genesis, 2013c).
- Environmental Assessment of Options for the Management of the Murchison Drill Cuttings Pile (BMT Cordah, 2013).

10.2 Potential Sources and Magnitude of Impact

Decommissioning of the Murchison Facilities including the wells, pipelines and bundles will require work at, or near, the seabed which may result in short-term disturbance to background seabed sediments and, in some cases, to contaminated drill cuttings. Short-term environmental impacts associated with seabed disturbance during the decommissioning of the Murchison Facilities include:

- removal of the bundles; and
- removal of subsea wellhead and guide bases during well P&A.

In addition, decommissioning the drill cuttings pile, jacket footings and pipeline PL115 *in situ* may lead to some long-term impacts arising from:

- the eventual collapse of the Murchison jacket footings;
- the physical presence of the cuttings pile; and
- physical presence of rock-placement covering pipeline PL115.

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

10.2.1 Removal of the Bundles

The associated bundles PL123, PL124 and PL125 around the Murchison Platform have been flushed and left in place. All bundles with exception of PL123 have been disconnected from the associated wellheads (Section 4). The recommended option for decommissioning the exposed

PL123, PL124, and PL125 bundles is full removal through cutting techniques as outlined in Section 4 with subsequent lifting operations.

The cutting and lifting of PL125, however, will involve some disturbance of the drill cuttings pile as the bundle will be cut at the connection to the towhead located at the edge of the drill cuttings pile. This disturbance will be relatively small and occur from the manoeuvring of the ROV and cutting equipment.

The total duration for the bundles removal operations is expected to be 83 days

10.2.2 Well P&A

Well decommissioning activities include (Section 4):

- the P&A of well 211/19-2 and removal of the wellhead;
- removal of guide-base and protection structure for well 211/19-4;
- P&A of 98 platform wells in 33 slots; and
- recovery of associated tubing and conductors.

The conductors will be cut at approximately 125 m depth, with approximately 15 m of conductors extending above the cuttings pile, and terminating 13 m below the top of the jacket footings (Section 4.4.2). Therefore, disturbance of the pile during cutting operations is not anticipated.

The subsea equipment such as the subsea wellhead 211/19-4 and the guide bases are located outside the 500 m zone where sediments have low contamination levels comparable to background North Sea sediments. Direct impact from handling of heavy inventory such as subsea wellheads, is expected to be localised as the activity will be performed in a controlled manner.

The total duration of the well P&A operations are expected to be 660 days.

10.2.3 Eventual Collapse of Jacket Footings

The jacket structure will be cut above the jacket footings at approximately 112 m depth (Section 4) with approximately 29 m of jacket footings extending above the drill cuttings pile which is approximately 15 m in height. Therefore, disturbance of the pile during cutting operations is not anticipated.

Each bottle leg comprises various different components, including eight piles and pile sleeves, one central leg, shear plate connectors, ring stiffeners and the mud mat, which all vary in thickness of steel and consequently will corrode at different rates. A study commissioned to determine the likely corrosion of the Murchison jacket footings estimated that at a corrosion rate of 0.1 mm steel/year, definite failure of the members could occur at 70 to 80% wall thickness loss. Failure of the leg structures is expected to occur between 300 and 1,000 years and due to the number of piles supporting each leg a local failure would be unlikely to cause global failure (referenced in Genesis, 2013c).

Table 10.1 provides an indication of the different leg components over the predicted window (300 to 1,000 years) for leg failure.

Table 10.1: Corrosion rates for the different structural members

Bottle leg component	Original steel thickness	Potential steel thickness (MM) (corrosion rate of 0.1 mm/year)	
		300 years	1,000 years
Pile (8 piles in total)	63 mm	33 mm*	0 mm*
Pile sleeve	20 mm	0 mm	0 mm
Central leg	45 mm	15 mm	0 mm
Shear plate connectors	25 and 35 mm	5 mm	0 mm
Ring stiffeners	28 and 32 mm	2 mm	0 mm
Mud mat	45 mm	15 mm	0 mm

*Corrosion rates are expected to be lower than these values owing to grout and limited water exchange within the centre of the pile

Referenced in: Genesis (2013c)

On the basis of the original steel thickness of each component, the pile sleeves are likely to be the first components to fail, followed by the shear plate connectors and ring stiffeners (Table 10.1; Genesis, 2013c). Failure of the mud mat and the central leg are likely to follow after some time, and the eight piles securing each bottle leg to the seabed, which have the greatest steel thickness, are likely to be the last components to fail. Early loss of shear connectors, ring stiffeners and the mud mat would lead to release of individual leg components and their subsequent independent collapse. It is likely that the central leg will fail before the individual piles and that it would knock over one or two of the piles as it gradually slumps into the footprint of the jacket. The remaining piles would fail individually at varying times depending on the overall and local corrosion rates (Genesis, 2013c). The collapse of each pile is expected to be gradual as the steel bends under the weight of the central pile above it, rather than an instant collapse like a dropped object.

The study indicated only two of the legs have the potential to fall on the drill cuttings pile, one which one may reach the centre of the pile and the other may impact the edge of the pile.

Each pile is 2.1 m in diameter and between 32 and 44 m in height, which could present a maximum surface area of 290 m^2 per pile which could contact the drill cuttings pile should the central leg collapse onto the pile. The original weight of the piles was approximately 100 tonnes and based on the corrosion predictions used by Atkins (70 to 80%), it is estimated that at the time of failure each pile may weigh approximately 20 to 30 tonnes (Atkins, 2011c).

10.2.4 Physical Presence of the Cuttings Pile

The Murchison drill cuttings pile has a measured volume of 22,545 m^3, and is located beneath the southeast edge of the platform (ISS, 2011). The pile has a maximum height of 15.34 m and a footprint on the seabed of 6,840 m^2 (ISS, 2011).

OBM was used and discharged with drill cuttings at 48 of the 98 wells drilled in this field (ERT, 2008). Analysis of the chemical properties of the Murchison drill cuttings pile sediments indicates that concentrations of THC, PAH, PCBs, APEs, TBT and heavy metals were elevated in the drill cuttings pile in comparison to mean concentrations from sediments in the wider Murchison area (Section 5).

The potential environmental impacts associated with the different options for the management of the Murchison drill cuttings pile have been assessed by CNRI (BMT Cordah, 2013) and modelling of the long-term fate of the cuttings pile left *in situ* has been performed as per the OSPAR Recommendation 2006/5 (Genesis, 2013b). OSPAR Recommendation 2006/5 sets out a management regime for the decommissioning of historic OBM cuttings piles. This is based on criteria thresholds against which the level of pollution attributable to a historic drill cuttings pile may be measured, to determine whether the level of pollution could be considered significant. The Murchison drill cuttings pile is below the OSPAR thresholds for both “total rate of oil release into the water column” and “persistence over the area of seabed contaminated” (Genesis, 2013a; ERT, 2008).

10.2.5 Rock-Placement of Pipeline PL115

The recommended option for decommissioning the 19.1 km 16” oil export pipeline (PL155), which runs between the Murchison Platform and the Dunlin A Platform, is complete burial by rock-placement (Section 4). Approximately 10.9 km of the pipeline is presently covered by rock-placement, leaving 8.2 km to be covered with rock. As described within Section 4, approximately 53,000 tonnes of rock will be required to provide sufficient cover for the pipeline, resulting in a footprint of approximately 0.043 km^2 assuming the rock-placement would be 8,500 m by 5 m.

The burial of the PL115 pipeline will create a local, short-term impact from the disturbance of the seabed during the removal of the spool-pieces at the pipeline ends and during the rock-placement. The duration of these activities is expected to last 12 days.

The long-term consequences of the full burial of the pipeline PL115 are expected to result from the slow corrosion of the pipeline over time with eventual collapse, leaving a trace of corroded metal and broken concrete buried under the rock-placement mass. Since the pipeline will have been flushed and cleaned prior to burial there would be no release of hydrocarbons into the sea. It is expected that the 226 aluminium anodes, placed every 85 m along the pipeline, will slowly dissipate into the sea and would cease to provide cathodic protection. The slow release of the aluminium is expected to have a negligible impact on the local environment.

10.3 Impacts on Sensitive Receptors

The potential impacts to the water column or seabed are identified for each of the decommissioning activities or outcomes in Table 10.2.

Table 10.2: Summary of potential sources of seabed disturbance and the resulting 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	Oxygen depletion	Change in habitat
Remove bundle PL125	Short-term	Short-term	Short-term	-	-	-
Subsea materials and remaining bundle removal	-	Short-term	-	-	-	-
Eventual collapse jacket footings	Short-term	Short-term	Short-term	Short-term	-	-
Cuttings pile left *in situ*	Long-term	-	Long-term	-	Long-term	-
Rock-placement PL115	-	Short-term	-	Long-term	-	Long-term

The types of impact arising from the Murchison decommissioning activities and outcomes listed in Table 10.2 can be summarised as:

- disturbance of contaminated drill cuttings and sediments;
- disturbance of non-contaminated sediments;
- habitat change; and
- long-term presence of the drill cuttings pile.

These impacts are assessed in the following sections to determine the potential scale of the impacts to fauna and to local water and sediment quality.

10.3.1 Disturbance of Contaminated Drill Cuttings and Sediments

The decommissioning activities or outcomes that could cause disturbance to drill cuttings pile sediments and result in a release of contaminants from the pile into the adjacent water column and over adjacent sediments include:

- the removal of the bundle PL125 (Section 10.2.1);
- the eventual collapse of the Murchison jacket footings (Section 10.2.3);

The cut location for the bundle PL125 is situated at the edge of the drill cuttings pile. Currently, the bundle is laying on top of some drill cuttings material but is not covered by it, therefore the potential disturbance is considered to be very small and of low significance with the small volume of sediment disturbed rapidly resettling within the immediate area.

The potential impact associated with the disturbance of the drill cuttings from collapsing jacket members, as a result of the long-term degradation of the footings, would be dependent on the size of the failed brace or leg section. Small braces are likely to disturb a relatively small volume of drill cuttings when compared to the main leg, which may weigh approximately 63 to 94 tonnes and would be a maximum of 44 m in height. The main leg is likely to disturb a larger volume of cuttings from deeper within the pile.

Given the very low hydrodynamic forcing at the depth of the Murchison drill cuttings pile it is likely that the majority of the disturbed cuttings would resettle over the already contaminated sediments of the existing drill cuttings pile. If disturbed cuttings were relocated onto the adjacent seabed, this would result in the smothering of organisms which have recolonised the pile sediments and the release of contaminants into the water column and over surrounding sediments, thus delaying the surface recovery of sediments on and within the vicinity of the pile (BMT Cordah, 2013).

Under a worst case scenario where all the structural piles collapse into the cuttings pile, falling sequentially over a period of 275 days, the majority of re-suspended sediments are predicted to deposit within 400 m of the cuttings pile, with finer components travelling considerably further (Genesis, 2013c). Maximum thickness of these re-suspended sediments are predicted to be approximately 3.5 mm for the collapse of a single pile and 27.5 mm for the collapse of all the piles. The maximum thickness is predicted to occur within 40 m of the discharge point and decreasing rapidly with distance. At a distance of one km, the maximum depositional thickness is predicted to be a maximum of 0.1 mm along the dominant current axis (Genesis, 2013c).

Figures 10.1a and 10.1b illustrate the modelled deposition thickness for a single pile collapsing (Figure 10.1a) and all the piles falling sequentially (Figure 10.1b).

Benthic Impacts

The direct effects of seabed perturbation include mortality as a result of physical disturbance, smothering by moving heavy subsea equipment such as the bundle, and in extreme cases by the displaced and re-suspended sediment and habitat modification due to changed physio-chemical characteristics (such as sediment porosity and oxygenation). The disturbance of the underlying cuttings pile may cause leaching of hydrocarbon contaminants into the water column along with the suspension of particle bound contaminants that may impact on the local benthic fauna through assimilation into the gut of suspension feeders (Breuer *et al*., 2004).

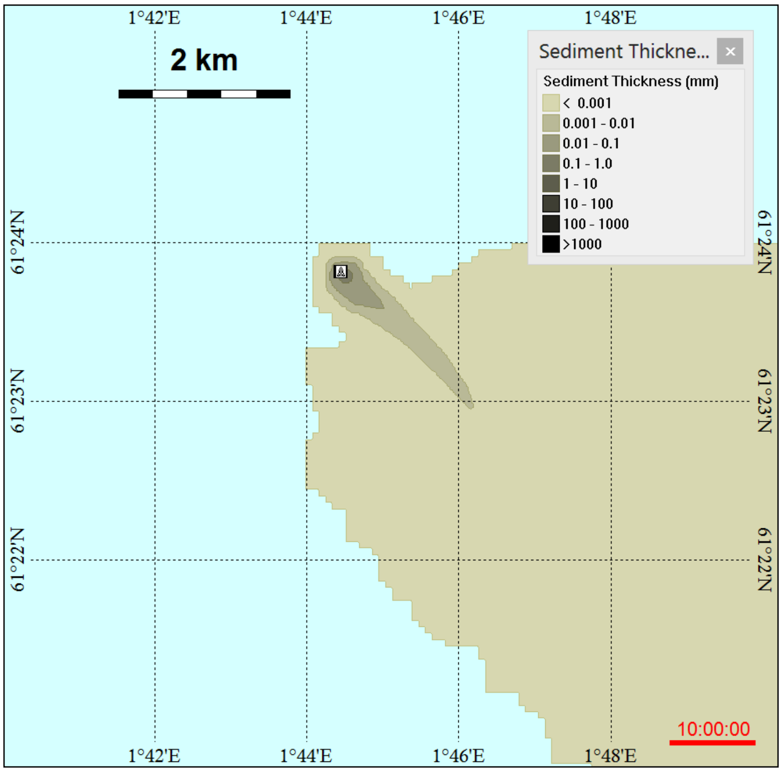

Figure 10.1a: Modelled deposition thickness of cuttings re-suspended resulting from the collapse of a single pile

Source: Genesis (2013c)

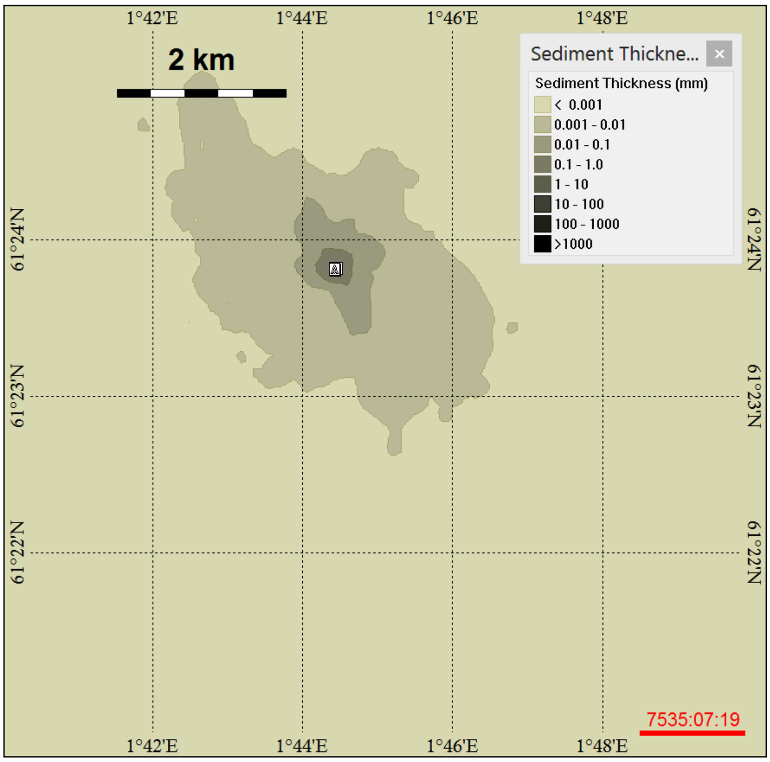

Figure 10.1b: Modelled deposition thickness of cuttings re-suspended resulting from the collapse of all the piles

Source: Genesis (2013c)

Seabed sediments

Seabed sediments in the wider Murchison area comprise poorly or very poorly sorted medium sands with a low proportion of fines; however, within 250 m of the Murchison Platform sediment comprises extremely poorly sorted coarse silt with over 50% fines (Section 5).

The collapse of the jacket footings may result in an increase in the percentage of fines material in the receiving sediments, resulting from disturbed cuttings and sediments relocating and settling over the receiving sediments. However, the immediate receiving area already has elevated percentage fines from the original drilling operations, and any impacts associated with any change in sediment grain size would be smaller than if the cuttings were distributed on previously undisturbed sediments further away from the Murchison Platform (BMT Cordah, 2013).

Hydrocarbon concentrations within the wider Murchison Facilities area are generally within expected background levels for the northern North Sea, but hydrocarbon concentrations within 250 m of the Murchison Platform are elevated above background concentrations (BMT Cordah, 2013). Relatively small volumes of cuttings material would be disturbed as a result of the jacket legs collapse. This material would be expected to travel a few hundred metres from the discharge point, and result in sediment hydrocarbon levels exceeding 50 mg/kg over an area of 0.044 km^2. The impacts associated with this disturbance are predicted to remain well within the historic “effect footprint” of the Murchison cuttings pile which is 0.566 km^2 (Genesis, 2013c).

Benthic fauna

The macrofaunal community of the Murchison Field is typical of the wider northern North Sea, but within 250 m of the platform and on the Murchison drill cuttings pile, the macrofaunal community shows some indication of being moderately modified (BMT Cordah, 2013).

Suspension of cuttings material as a result of jacket leg collapse is likely to physically disturb benthic fauna living on or in the sediment in the area around the disturbance location, smothering benthic fauna in the immediate discharge area. Studies have shown that recolonisation of cuttings pile sediments may commence one to two years after the cessation of cuttings discharges (UKOOA, 1999).

Resettlement of contaminated sediment onto the seabed could be toxic to benthic organisms. As a result, recolonisation is generally characterised by the appearance of opportunistic species such as *Capitella capitata* which are tolerant to hydrocarbons and physical disturbance, and is one of the dominant species present on the Murchison drill cuttings pile (Section 5).

Studies of the effects of cuttings piles in the Norwegian Sector of the North Sea have indicated that heavily contaminated sediment prevented macrofaunal recolonisation during the first five years. It was reported that the layer of contaminated cuttings formed a barrier to burrowing organisms and consequently recovery may be extremely slow (Bakke *et al.* 1989 cited in UKOOA, 1999). Recolonisation of the contaminated sediments increases with the biodegradation of contaminants within the surface layer of the disturbed sediments and, therefore, the gradual reduction in the overall contaminated area, especially in the area of thinly deposited material (BMT Cordah, 2013).

The maximum sedimentation thickness is predicted to be 27.5 mm, within 40 m of the disturbance. This is a relatively small area where the suspended sediment has been deposited in a thicker layer and would persist for a much longer period (>40 years) as only the upper oxygenated layers of deposited sediments would experience biodegradation. Faunal samples collected from the existing Murchison cuttings pile indicate that whilst recolonisation of the contaminated sediments has occurred, samples exhibit low species diversity and abundance, and pollution-tolerant species still dominate approximately 20 years after drilling discharges ceased (BMT Cordah, 2013).

Disturbance of drill cuttings as a result of the jacket leg collapse is predicted to have a low significance to benthic organisms, as the initial impact area would not significantly exceed the area of the current pile accumulation and would be well within the existing background effects footprint of 50 mg/kg. Within one year post collapse the impact area is predicted to have receded to within the footprint of the existing pile accumulation (BMT Cordah, 2013).

Water Quality

The re-suspension of drill cuttings will result in the release of contaminants and an increase in turbidity, resulting in the localised reduction in water quality. The phytoplankton and zooplankton communities in the Murchison area are typical of the northern North Sea, with a phytoplankton community dominated by the dinoflagellate genus *Ceratium* and a zooplankton community dominated by *Calanus* species (Section 5).

Impacts to the water column as a result of the jacket leg collapse would be very short lived, with the impacts from each of the 24 structural piles within the footings lasting for 16 hours, equivalent to 384 hours or 16 days. The majority of material is predicted to remain within 20 vertical metres of the seabed. Although a small proportion of material will extend over 50 m into the water column, it would not exceed 5% environmental risk and consequently is considered to be a low environmental impact (BMT Cordah, 2013).

Fisheries Impacts

Jacket leg collapse is considered to be of low risk to the water column as the associated impacts are predicted to be very localised (<1 km^2 of seabed and <0.009 km^3 water volume) and of very short duration (<16 days).

Therefore it is possible that a small number of demersal and pelagic fish might be temporarily disturbed by the jacket leg collapse. However, fish are highly mobile organisms and are likely to avoid areas of re-suspended sediments and turbulence during the gradual collapse of the Murchison jacket legs.

The collapse of the jacket legs could occur at any point in time during the year, and could therefore coincide with spawning periods for cod whiting, haddock, Norway pout and saithe (Section 5; Coull *et al*., 1998 and Ellis *et al*., 2010). The Murchison Field is also located in an area where herring, ling, mackerel, spur dog, haddock, Norway pout and blue whiting are known to have larval nursery grounds (Section 5; Coull *et al*., 1998 and Ellis *et al*., 2010). Of the fish nursery areas which coincide with the Murchison Field, ling is the only species which has a demersal juvenile phase.

Of the fish spawning species which coincide with the Murchison Field, Norway pout is the only species which spawn onto the seabed; all the other species spawn pelagic eggs and larvae. It is unlikely that pelagic eggs and larvae would be affected by the re-suspended material from the drill cuttings pile as modelling studies predict the re-suspended material will remain within a few metres of the seabed and for a short time (BMT Cordah, 2013).

The Murchison Field is not located within an area of high spawning intensity for Norway pout (Section 5), and the size of the potentially affected area is very small (<0.6 km^2) in comparison to the spawning area used by Norway pout in the northern North Sea (>10 Quadrants, each 250 km^2) (BMT Cordah, 2013). Ling nursery grounds are spread across the northern North Sea and off northwestern Scotland, with the largest catches in deeper waters (Section 5; Ellis *et al*., 2010). The Murchison area lies on the northeastern edge of the ling nursery grounds and therefore accounts for a very small percentage of the available ling nursery area.

The release of contaminants from the sediments may affect some of the demersal fish species such as cod, whiting, saithe, haddock, Norway pout and ling which generally feed on benthic organisms (Section 5). Hydrocarbons present within the drill cuttings can have a direct impact on fish species:

- tainting of fish for human consumption;
- disease in adult fish such as abnormal tissue growths and other lesions; and
- physiological impacts such as repression of the immune system in adult fish (BMT Cordah, 2013).

Historical studies have recorded taint in fish caught close to oil and gas platforms (<1,000 m), mostly in demersal species (BMT Cordah, 2013). It is thought that taint contamination of benthic species could be due to ingestion of contaminated sediment (BMT Cordah, 2013). Hydrocarbons, especially PAHs such as those found in OBM drill cuttings, have long been known to cause teratogenicity, mutagenicity and carcinogenicity in fish through chronic and acute effects on tissues (BMT Cordah, 2013). The main mechanism of toxicity of PAH in fish is through the disruption of cellular processes through an interference with the function of cellular membranes as well as with enzyme systems which are associated with the membrane.

The incidence of such impacts on adult fish has not been extensively studied in relation to contamination from drill cuttings piles, partly because fish are highly mobile (BMT Cordah, 2013). Many of these impacts have a long development time and are likely to have multiple causes. Exposure to drill cuttings contamination is likely to be a contributory factor rather than the sole cause in the incidence of disease, but its relative contribution is difficult to establish (BMT Cordah, 2013).

The release of contaminants from the sediments may affect the early life stages of some fish species, but this will be localised and not likely to have an impact on that species' population or its long-term survival.

10.3.2 Disturbance of Non-Contaminated Sediments

Several decommissioning activities could cause disturbance to seabed sediments that are outside the drill cuttings pile footprint and where levels of contaminants approximate those of background North Sea sediments. These activities include rock-placement over the exposed sections of pipeline PL115 (Section 10.2.2), removal of mattress protection on PL115 (Section 10.2.2) and removal of subsea equipment such as subsea wellheads, guide-base and protection structures (Section 10.2.3).

Sediments that are re-suspended during placement of the rock will drift with seabed currents before settling out over adjacent areas of seabed. The lateral spread of the re-suspended sediments is expected to be limited due to the weak subsea currents in the Murchison Facilities area and at worst case this could have a minor impact on the local community. 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 impact can be comparable to the natural burial of fauna from sediment movement due to subsea currents.

Following completion of the well P&A activities, the natural physical processes of sediment transportation and biological settlement are 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).

10.3.3 Habitat Change

Habitat change will result from the introduction of hard substrate into a predominantly soft substrate environment. Decommissioning the 16" oil export pipeline by covering with rock protection (Section 10.2.5) has been assessed to be of 'moderate significance' to the environment and would result in a modification of the substrate and habitat type in the local area.

Placement of protective rock-placement will have an impact on the structure of the seabed in these areas. The impact will be limited to approximately 0.057 km^2. Sediment analysis throughout the Murchison area indicated a low variation in sediment types which were generally classified as moderate to very poorly sorted, medium sand, with the exception of one station located 250 m to the south of the Murchison Platform which comprised very fine sands (Fugro ERT, 2013; Hartley Anderson Limited, 2007). Sediments were noted to contain small areas of cobbles/boulders and small amounts of gravel and shell debris (Fugro ERT, 2013). A pre-decommissioning debris survey conducted within the Murchison 500 m zone identified 181 boulders with a length measuring of ≥1m, or a width or height measuring ≥1 m (ISS, 2011).

The proposed rock-placement will result in a local impact that is not likely to constitute a significant impact as the site surveys undertaken indicate that some hard substrate already exists in the area in the form of glacial rafted boulders. Additionally, the existing 11 km of rock-placement along the pipeline will remain *in situ* as part of the decommissioning. As organisms associated with hard substrates will be naturally present in the area, areas of rock-placement 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-placement 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).

10.3.4 Long-term Presence of the Drill Cuttings Pile

Whilst the Murchison drill cuttings pile falls below the OSPAR Recommendation 2005/6 thresholds, if the pile were left *in situ* to degrade naturally it is likely that the relatively low rate of leaching of contaminants into the water column and the long-term pile presence and contaminant persistence would result in a continued, albeit relatively low, impact on water and sediment quality and local benthic communities.

Leaching of Contaminants

The OSPAR Recommendation 2006/5 states:

The rate of oil loss should be assessed on the basis of the quantity of oil lost from the cuttings pile to the water column over time. The OSPAR threshold for the leaching rate of oil loss from the cuttings pile to the water column is 10 t/year.

Oil loss into the overlaying water column from the existing drill cuttings pile is currently predicted to be approximately 1.2 tonnes/year from a pile with a footprint area of 6,800 m^2. The long-term environmental risk to the seabed from the drill cuttings pile is predicted to be a result of oxygen depletion and PAH concentrations (Genesis, 2013a). Alkylphenol Ethoxylates (APEs) were not assessed within the drill cuttings pile modelling, however, results from the pre-decommissioning environmental survey (Section 5) indicated that elevated levels of APEs were present in the drill cuttings pile accumulation and at one station 250 m southeast of Murchison. APEs are listed by OSPAR as chemicals for priority action due to being toxic to marine organisms, bioaccumulative and persistent in the environment. Nonylphenol, octylphenol and their derivates (ethoxylates) are suspected endocrine disruptors which induce sex change in male fish. Therefore, it is likely that APEs will contribute towards the overall environmental risk to benthic and demersal feeding organisms such as fish.

Leaching of oil into the water column is also likely to result in the release of contaminants (such as PAH and APEs) into the water column. Hence the core area of the pile, if left *in situ*, has the potential to cause toxic effects to benthic and demersal organisms through continued leaching of hydrocarbons (BMT Cordah, 2013). Environmental risk to the water column from the higher leaching rate of 1.2 tonnes / year is predicted to be below the 5% risk value such that it is not considered to pose a significant risk to pelagic organisms.

Long-term Pile Presence and Contaminant Persistence

The OSPAR Recommendation 2006/5 states:

The persistence should be assessed on the basis of the area of the seabed where the concentration of oil remains above 50 mg/kg and the duration that this contamination level remains. The OSPAR threshold for persistence over the area of contaminated seabed is 500 km^2yrs.

Modelling predicted the area of seabed for which the concentration of oil exceeds 50 mg/kg (contaminated footprint) over the 40 year modelling period (BMT Cordah, 2013). The contaminated area multiplied by the duration (footprint and persistence) was calculated, beginning a minimum of 6 years after the last discharge of OBM which was in 2000. Thus, a cumulative footprint and persistence has been calculated. Taken to the end of the 40 year simulation period, the area persistence is less than 11 km^2years, which is well below the OSPAR criterion of 500 km^2years (BMT Cordah, 2013).

Analysis of survey data from the drill cuttings pile and surrounding sediments indicates that the Murchison cuttings pile falls below both OSPAR thresholds (Genesis, 2013a; ERT, 2008). As such, no further action is required with regard to the OSPAR Recommendation 2006/5 and the cuttings pile may be left *in situ* to degrade naturally. The UKOOA drill cuttings initiative found that the potential environmental impact of a cuttings pile is not considered to be significant if the pile characteristics fall below the two OSPAR thresholds (UKOOA, 2002).

Modelling results predict that the area of seabed where THC exceeds 50 mg/kg would decrease to less than 0.5 km^2 by 2019, from an initial area of more than 1 km^2 in 2000 (Figure 10.2; Genesis, 2013b).

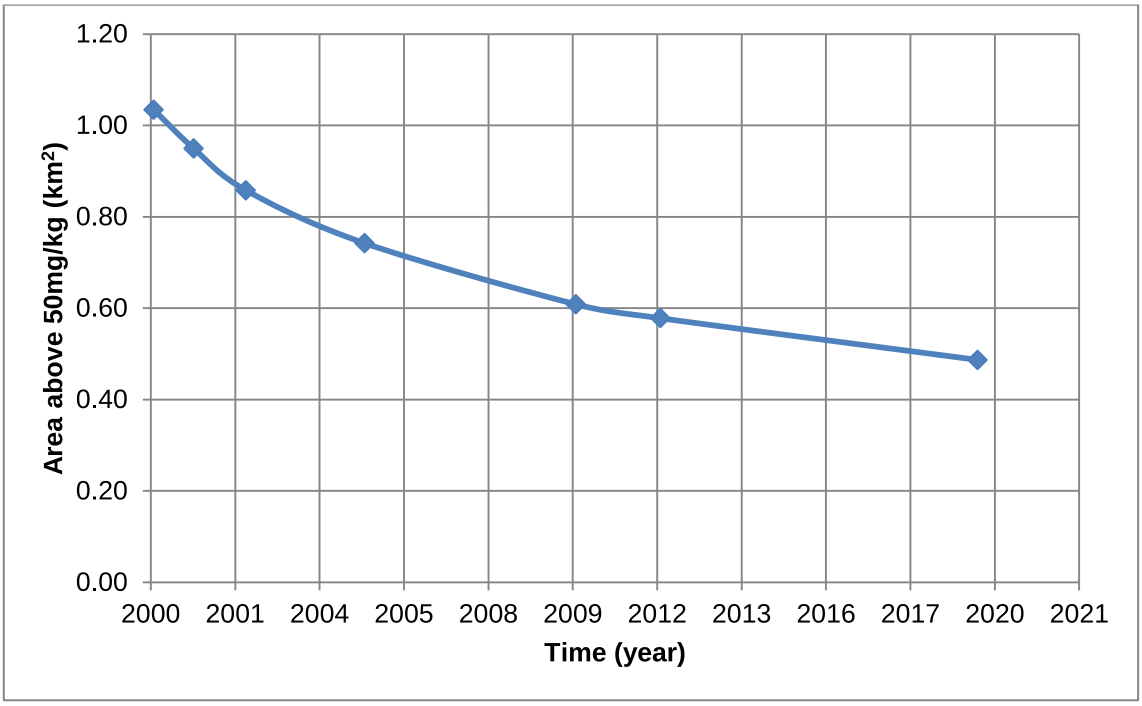

Figure 10.2: Area of seabed (km^2) exceeding 50 mg/kg predicted over 20 years with the Murchison cuttings pile left *in situ*.

Source: Genesis (2013b)

The persistence of the drill cuttings pile has also been assessed as to the distribution of contaminants over time. Figure 10.3 illustrates a series of contour plots which predict THC in the sediment during OBM discharges (commencing 1983), at the end of the Murchison drilling period, (which was in 2000), and predicted concentrations in 2013 and 2019. The contour plots indicate a trend of decreasing hydrocarbon concentration in the sediments surrounding the Murchison Platform where drill cuttings depositions are thinner than in the centre of the pile. Within an approximate 7 km radius, THC concentrations in the surrounding sediments are predicted to be <0.001 mg/kg by 2019 (Genesis, 2013b).

Figure 10.4 provides an illustration of the predicted recovery of the seabed in the form of environmental risk contour plots over time. The contour plots indicate a trend of decreasing environmental risk, such that by the end of 2019 areas where the risk to >5% PAF are predicted to be restricted to within approximately 1 to 2 km of the Murchison Platform. Calculation of the environmental impact factor (EIF) value also indicates a decreasing trend such that the EIF is predicted to have decreased from >3,900 following initial drilling discharges in 1983 to a value of 300 by the end of 2019, which equates to 3 km^2 of seabed above a risk level of 5%.

The long-term environmental risk to the seabed resulting from leaving the accumulation of the drill cuttings pile *in situ* is predicted to be predominantly a result of oxygen depletion in sediments and elevated contaminant concentrations (such as PAH and APEs) (Genesis, 2013a; BMT Cordah, 2013).

The cumulative impact for all North Sea cuttings piles is small compared with other inputs to the North Sea, e.g. annual input of hydrocarbons from all piles at 330 tonnes to the water column in the North Sea equates to 0.5% of that from other sources at circa 65,000 tonnes (UKOOA, 2002). However, the total volume of hydrocarbons estimated to be contained within all the North Sea cuttings piles is significant at around 160,000 tonnes (from 30 years of discharge) (UKOOA, 2002).

Benthic Impacts

Leaving the cuttings pile *in situ* will result in their natural degradation, with contaminants leaching at a relatively low rate into the water column. The long-term presence of the cuttings pile and the contaminant persistence would result in a continued, albeit relatively low, impact on sediment quality and local benthic communities.

Oil and associated contaminants (such as PAH and APEs) will continue to leach through the layers of the cuttings pile continually re-contaminating the surface layers of the pile as they start to biodegrade. The core accumulation of the pile, if left *in situ*, therefore has the potential to cause toxic effects to demersal organisms through continued leaching of hydrocarbons. The area of sediment impacted would be limited to the small footprint area of the existing pile accumulation (<0.01 km^2). Sessile demersal species would be at the greatest risk, with other benthic deposit feeding organisms at risk of bioaccumulation through the food chain. The chemical and biological extent of the pile is expected to diminish gradually over time and be limited to small releases spatially contained within the footprint of the bulk of the pile material. PAHs and APEs associated with cuttings piles within the anoxic deeper layers may be very persistent. If these drill cuttings are disturbed and redistributed, the release of PAH, APEs and their derivatives have the potential to cause biological effects such as toxicity and endocrine disruption to benthic and demersal organisms (BMT Cordah, 2013).

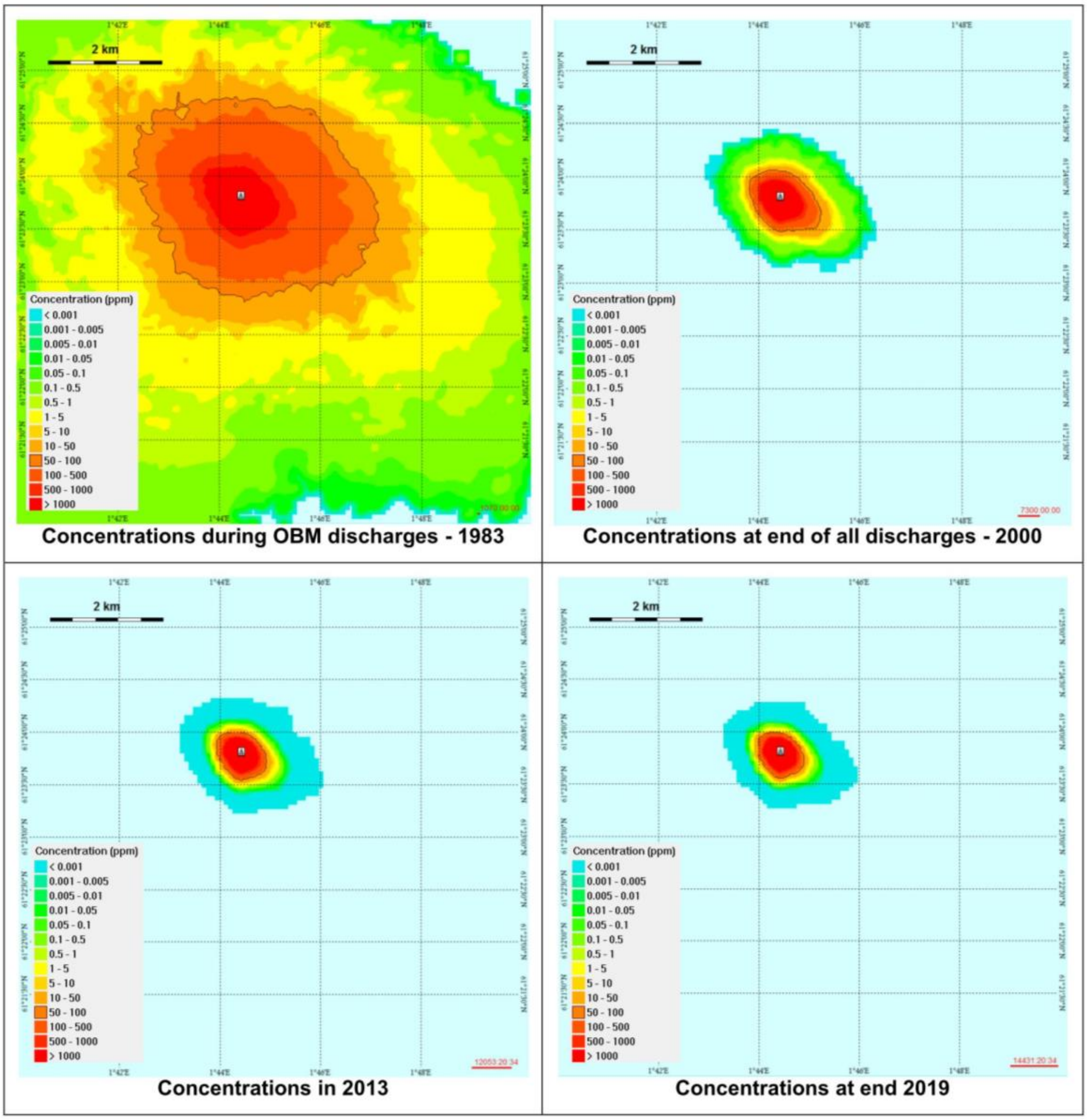

Figure 10.3: Total hydrocarbon concentration in sediments over time [50 ppm = 50 mg/kg] (Genesis, 2013b)

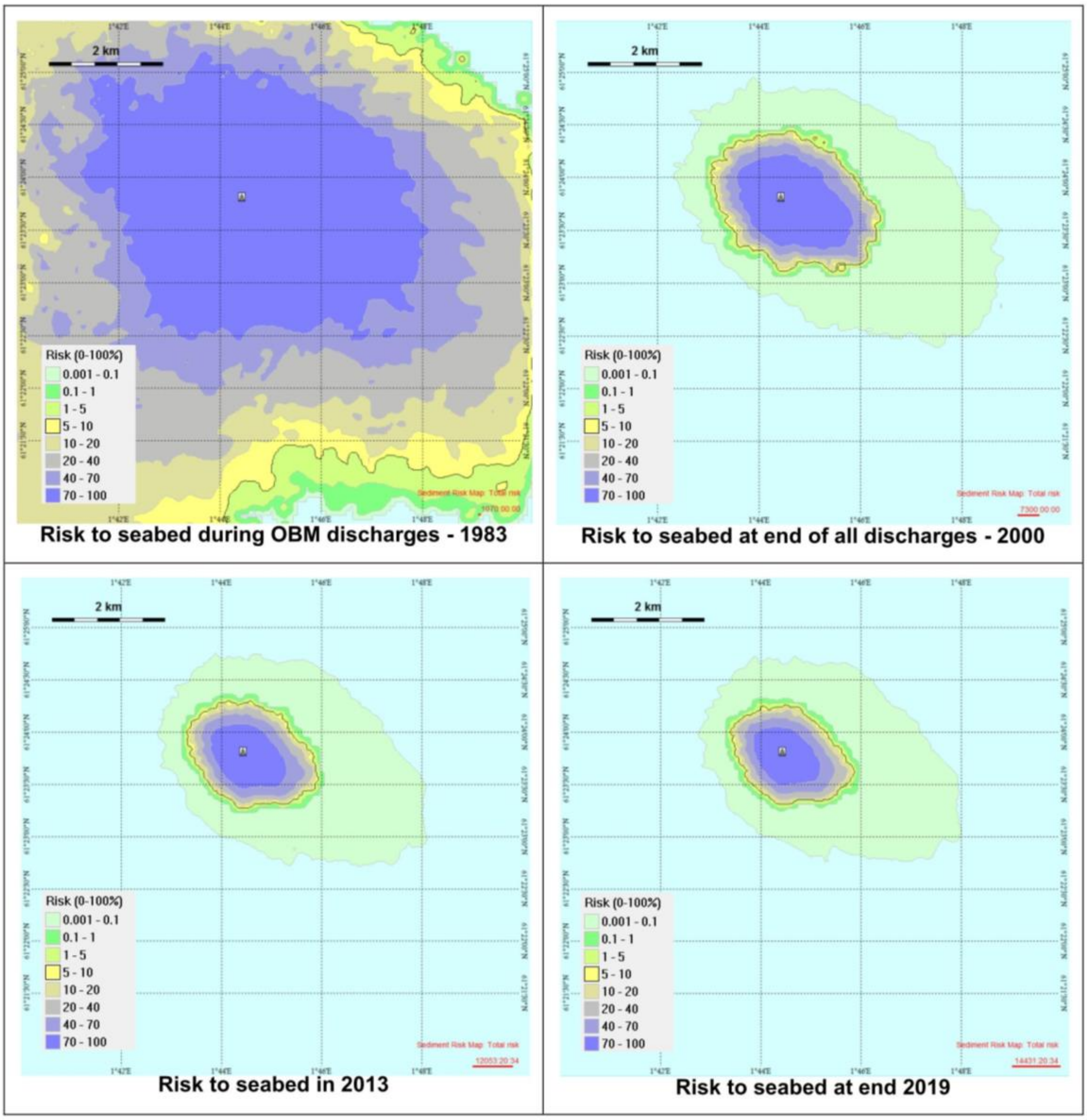

Figure 10.4: Estimation of environment risk resulting from the Murchison pile left *in situ* (Genesis, 2013b)

The key at the top-middle relates to the entire figure

In water depths over 120 m, the presence of hydrocarbons from the pile material is likely to be measured in centennial timescales e.g. 500 to 1,500 years (BMT Cordah, 2013). The water depth at the Murchison Field is 156 m (Section 5). The Murchison drill cuttings pile is expected to persist physically for an indeterminate length of time, and its chemical and biological footprint is expected to diminish slowly but be detectable for many hundreds of years (Genesis, 2013a).

Fisheries Impacts

Leaving the cuttings pile *in situ* will result in their natural degradation, with contaminants leaching at a relatively low rate into the water column. The long-term presence of the cuttings pile and the contaminant persistence would result in a continued, albeit relatively low, impact on demersal fish species.

The potential impacts to fisheries associated with the leaching of contaminants and hydrocarbon/contaminant persistence from the cuttings pile are discussed in Section 10.3.1.

10.4 Mitigation

CNRI have carefully considered different decommissioning options during the CA in the initial project stage and have identified the potential sources of impacts with regard to seabed disturbance. Table 10.3 below summarises the potential sources of impact and planned mitigation measures.

Table 10.3: Potential sources of impact and planned mitigation measures

Potential sources of impact	Planned mitigation measures
Subsea equipment cutting and lifting	Cutting and lifting operations of subsea equipment will be controlled by ROV to ensure accurate placement of cutting and lifting equipment and minimise any impact on seabed sediment.
Rock-placement	A rock-placement vessel or ROVSV will be used. The rock mass will be carefully placed over the designated areas of the pipeline by the use of an ROV controlled fall pipe equipped with cameras, profilers, pipe tracker and other sensors as required. This will control the profile of the rock covering and accurate placement of rock over the pipeline to ensure rock is only placed within the planned footprint with minimal spread over adjacent sediment, minimising seabed disturbance. The profile of the rock-placement will allow fishing nets to trawl over the rock unobstructed. Suitably graded rock will be used to minimise the risk of snagging fishing gear.
Drill cuttings pile management.	Drill cuttings management options have been considered in detail (BMT Cordah, 2013). The outcome from the CA process concluded that leaving the cuttings pile *in situ* is the most environmentally justified method for decommissioning compared with methods that involve extensive disturbance of the cuttings pile and re-suspension of OBM contaminated sediments into the environment.

10.5 Residual, Cumulative and Transboundary Impacts

Following completion of the Murchison Decommissioning Programme the only inventory and facilities that will be left post decommissioning are:

- the pipeline PL115 which will be buried under rock along its entire length; and
- the drill cuttings pile and the associated derogated jacket footings.

The residual impacts associated with the decommissioning operations are from the long-term natural degradation of the drill cuttings pile over time and presence of jacket footings and buried pipeline.

Rock-placement over pipeline PL115 would alter the character of a very small proportion of the seabed. It is estimated that the total footprint area following the decommissioning of pipeline PL115 will be approximately 0.057 km^2. Since most of the pipeline (>58%) is already covered in rock, rock-placement of the remaining exposed areas will increase the existing hard, rock habitat.

The total footprint area following post decommissioning of the Murchison drill cuttings pile is 0.0064 km^2. After 30 years of discharges, the total area of seabed experiencing disturbance due to all cuttings piles within the North Sea was estimated to be 1,605 km^2 or 0.23 % of the total area of the North Sea (CEFAS, 2001a) and therefore Murchison cuttings pile contributes 0.000004% of this total. This compares with an area of seabed that is affected by fishing, dredging and spoil dumping of approximately 130,000 to 369,000 km^2 per year (up to 50% of the North Sea CEFAS, 2001a). The cuttings pile falls below both relevant OSPAR thresholds (Genesis, 2013a; ERT, 2008) and, as such, the potential environmental impact of leaving the pile *in situ* is not considered to be significant (UKOOA, 2002).

The Murchison Platform is located 2 km west of the UK/Norwegian median line. Decommissioning activities are not anticipated to create any transboundary impacts.

10.6 Conclusions

The environmental impacts to the seabed emerging from the proposed Murchison Decommissioning activities and the natural degradation of the cuttings pile left *in situ,* include:

- The cutting and lifting of PL125 may create some disturbance of the drill cuttings pile as the bundle will be cut at the connection to the towhead located at the edge of the drill cuttings pile. This disturbance will be relatively small and occur from the manoeuvring of the ROV and cutting equipment. These activities will be controlled to ensure accurate placement of cutting and lifting thereby minimising the risk of pile disturbance.
- The long-term degradation of footings leading to falling jacket members and structures may result in a relatively small disturbance (0.7%) of the drill cuttings pile.
- Rock-placement activities associated with the pipeline burial are assessed as being of moderate 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. This impact will be minimised by controlled rock-placement over a minimal footprint. The profile of the rock-placement will allow fishing nets to trawl over the rock unobstructed.
- Long-term impacts from leaving the pile *in situ* are considered to be of low significance. Although toxic contaminants will be continually released, they will be low in concentration and limited to a very small area of the cuttings pile accumulation (<0.01km^2). Environmental risk to the water column from leaching is predicted to be below the 5% risk value such that it is not considered to pose a significant risk to pelagic organisms.

11.0 SOCIOECONOMIC IMPACTS

This section focuses on the broader socioeconomic considerations of the decommissioning of the Murchison Facilities. Socioeconomics is a subset of EIA that is concerned with the human dimensions of the environment and seeks to identify the social and economic impacts on people (Morris and Therivel, 2009).

The EIA scoping report (BMT Cordah, 2012a) and an Environmental Impacts Identification workshop (Appendix B) identified potential socioeconomic impacts associated with the Murchison Facilities decommissioning project as:

- Physical presence of decommissioning vessels causing potential interference to commercial fishing activities.
- Damage to or loss of gear as a result of subsea obstructions left *in situ*, posing potential snagging risks.
- Onshore impacts associated with the deconstruction, disposal, manufacture and recycling of materials on or near-shore.

Consequently, the socioeconomic impact study prepared by SFF Services (2012) provides a detailed assessment of commercial fishing activities in the northern North Sea between the Shetland Islands and Norway, relevant to the Murchison Platform and associated pipelines and assesses the impacts of various decommissioning options. This section of the ES summarises the assessment relevant to the recommended decommissioning options.

The onshore decommissioning yard has not been identified and will be determined during the contracting process. Therefore the onshore impacts associated with decommissioning are covered at a high level in this assessment and will be subject to further assessment once a decommissioning yard is chosen.

11.1 Methodology

The following section describes the socioeconomic impact assessment methodology used to assess the potential effects of decommissioning the Murchison infrastructure upon commercial fishing activities. Each decommissioning option has been separately assessed and ascribed a significance criterion, based on the matrices provided in the following subsections.

11.1.1 Significance Criteria

The parameters used to define the significance criteria used for the socioeconomic impact study are presented in Tables 11.1 and 11.2.

To assess the magnitude of an impact, three criteria are taken into consideration (Table 11.1):

- geographical extent of the impact;
- duration of the impact; and
- reversibility of the impact.

Table 11.1: Criteria to define magnitude of impact

Characteristic	Commercial Fisheries
Geographical extent of the impact	**Negligible**: Negligible decommissioning activities occurring and/or a very small area impacted by the decommissioning operations **Low:** Minor decommissioning activities occurring and/or a small area impacted by the decommissioning operations **Medium**: Moderate decommissioning activities occurring and/or a moderate area impacted by the decommissioning operations **High:** High decommissioning activities occurring and/or a large area impacted by the decommissioning operations
Duration of the impact	**Negligible:** Very short-term **Low:** Short-term **Medium:** Temporary (i.e. during decommissioning period) **High:** Permanent (i.e. for the longevity of any infrastructure left in place)
Reversibility of the impact	**Negligible:** No discernible, or very low change in normal fishing practices **Low:** Some amendment in fishing patterns but no significant change **Medium:** Fishing practices have limited access and there is a discernible reduction of fishing activity in the area **High:** Fishing activities are severely impacted or cannot resume in the area

Source: SFF (2012)

To assess the sensitivity of a receptor, four criteria are taken into consideration (Table 11.2):

- adaptability of the receptor;
- tolerance of the receptor;
- recoverability of the receptor; and
- value of the receptor.

Table 11.2: Criteria to define sensitivity of the receptor

Characteristic	Commercial Fisheries
Adaptability of the receptor	**Negligible:** Fishing vessels are not required to avoid or adapt to an effect **Low:** Fishing vessels are required to amend fishing practices slightly but no significant change **Medium:** Fishing vessels are limited in their ability to adapt and there is a discernible reduction in activity in the area **High:** Fishing vessels cannot adapt to fishing in the area
Tolerance of the receptor	**Negligible:** No discernible, or very low change in normal fishing practices **Low:** Outside of peak fishing periods **Medium:** During peak fishing periods **High:** Fishing activities cannot resume
Recoverability of the receptor	**Negligible:** Very short-term **Low:** Short-term **Medium:** Temporary (i.e. during decommissioning period) **High:** Permanent
Value of the receptor	**Negligible:** Very low loss of economic value of fishery **Low:** Low loss of economic value of fishery **Medium:** Moderate loss of economic value of fishery **High:** High loss of economic value of fishery

Source: SFF (2012)

11.1.2 Significance of Effect

The matrix presented in Table 11.3 has been used to determine the significance of impacts, taking into account the magnitude of an impact (Table 11.1) and the sensitivity of a receptor (Table 11.2).

Table 11.3: Impact Assessment Significance Criteria

		Sensitivity		
		Low	Medium	High
Magnitude	Negligible	Not significant	Minor Significance	Minor Significance
	Low	Minor Significance	Minor Significance	Moderate Significance
	Medium	Minor Significance	Moderate Significance	Major Significance
	High	Moderate Significance	Major Significance	Major Significance

Source: SFF (2012)

11.2 Potential Sources and Magnitude of Impact

The potential socioeconomic impacts arising from the decommissioning of the Murchison Platform and associated infrastructure are:

- interference to fishing activities;
- damage to or loss of gear; and
- onshore impacts.

11.2.1 Interference to Fishing Activities

During the decommissioning project, there will be potential for navigational conflicts between fishing vessels and decommissioning vessels transiting to and from the site. This could include towed gear vessels being required to alter towing direction, or the fouling of fixed gear markers. This interference by decommissioning vessels has the potential to impact more fishing vessels than those operating in the immediate vicinity of the Murchison Platform and associated pipelines, depending upon the location of the decommissioning port(s).

The majority of fishing activity in the vicinity of the Murchison Platform and associated pipelines is by vessels towing mobile gear. It is therefore considered that any interaction with vessels would result in changes in fishing patterns rather than damage to fishing gears and any loss of income would not be significant.

In accordance with Table 11.2 (Criteria to define sensitivity of the receptor), Table 11.4 provides SFF Services definition of the sensitivity of fixed gear vessels to interference.

Table 11.4: Criteria used to define the sensitivity of fixed gear vessels to interference

Characteristic	Commercial Fisheries
Adaptability of the receptor	Low: Fishing vessels are required to amend fishing practices slightly but no significant change
Tolerance of the receptor	Low: Outside of peak fishing periods
Recoverability of the receptor	Medium: Temporary (i.e. during decommissioning period)
Value of the receptor	Negligible: Very low loss of economic value of fishery

The magnitude of effect is dependent upon the location of the decommissioning port and the precautionary approach has assumed that transit routes will be in the vicinity of fixed and towed gear. As the mandatory 500 m safety zone will remain around the Murchison installation throughout the decommissioning project, the majority of the decommissioning vessels will be located within this zone and their effect on fishing vessels is therefore likely to be small. The magnitude of effect will therefore be dependent on the number of days decommissioning vessels are present in the vicinity of the Murchison Platform and associated pipelines outside of the 500m safety zone for each decommissioning option.

11.2.2 Damage to or Loss of Gear

Once decommissioning has been completed, there is potential for fishing gears to snag on subsea obstructions which have been left *in situ*, such as the jacket footings and pipeline PL115 which will be covered by rock-placement. The drill cuttings pile is located within the footprint of the jacket footings and therefore unlikely to present a snagging hazard. Vessels operating demersal gear have the highest risk associated with fastening gear on obstructions due to the nature of their activity. The majority of activity in the vicinity of the Murchison Platform and associated pipelines is by vessels operating demersal gear, therefore the risks associated with fastening gear on subsea obstructions will be highest for these vessels.

There is also potential for pelagic and fixed gear to snag on subsea obstructions. The risks associated with pelagic and fixed gears are considered to be lower than demersal gear however, due to the nature of the activities and the relatively low level of fishing activity occurring within the vicinity of the Murchison Platform and associated pipelines.

SFF Services (2012) defined the sensitivity of demersal, pelagic and fixed gear vessels to loss or damage of gear (Table 11.5).

11.2.3 Onshore Impacts

All structural material retrieved from the Murchison Field will be transported to shore for dismantling, and recycling or disposal as appropriate.

Processing would be undertaken by licensed contractors at licensed sites, and there would be few impacts from the controlled operations. CNRI's Duty of Care extends beyond the quayside and they would work with onshore licensed disposal sites to undertake all dismantling activities in a responsible manner (Section 12). The environmental impacts that would be experienced at any onshore site selected for receiving and dealing with material from the Murchison Field would be short-lived, localised and managed, and similar to those that have previously arisen during past commercial activities at the site.

Table 11.5: Criteria used to define the sensitivity of demersal, pelagic and fixed gear vessels to loss or damage of gear

Characteristic	Commercial Fisheries
Demersal Gear Vessels	
Adaptability of the receptor	Medium: Fishing vessels are limited in their ability to adapt and there is a discernible reduction in activity in the area
Tolerance of the receptor	Medium: During peak fishing periods
Recoverability of the receptor	High: Permanent
Value of the receptor	Low: Low loss of economic value of fishery
Pelagic Gear Vessels	
Adaptability of the receptor	Low: Fishing vessels are required to amend fishing practices slightly but no significant change
Tolerance of the receptor	Low: Outside of peak fishing periods
Recoverability of the receptor	High: Permanent
Value of the receptor	High: High loss of economic value of fishery
Fixed Gear Vessels	
Adaptability of the receptor	Low: Fishing vessels are required to amend fishing practices slightly but no significant change
Tolerance of the receptor	Low: Outside of peak fishing periods
Recoverability of the receptor	High: Permanent
Value of the receptor	Negligible: Very low loss of economic value of fishery

The magnitude of effect is dependent upon the decommissioning option under consideration and is defined in the relevant sections below.

11.3 Impacts on Sensitive Receptors

SFF Services (2012) identified the principal commercial species targeted by gear type within the vicinity of the Murchison Platform and associated infrastructure to be:

- mackerel and herring by pelagic trawlers;
- mixed demersal species by demersal trawlers; and
- mixed species by vessels operating fixed gear (i.e. longliners and gillnetters).

This section describes the effects of the impacts on these receptors, as assessed within Section 11.2.

11.3.1 Jacket Decommissioning – Partial Removal

Partial removal of the Murchison Platform will result in footings remaining between 32 m and 44 m above the seabed and a cuttings pile left *in situ*. It is considered that the presence of the footings will prevent vessels from operating within the boundaries of the platform and therefore the cuttings pile will not impact upon commercial fishing activities. It is considered, however, that the footings will pose snagging risks to fishing nets.

Once the platform has been decommissioned and removed, the mandatory 500 m safety zone will no longer apply. This allows for fishing activities potentially to be undertaken in close vicinity to the footings. Further, Linley *et al*. (2007) found that subsea offshore structures can act as fish aggregation devices (FADs), attracting various fish species, which could potentially attract fishermen aiming to increase their catch by targeting shoals of fish aggregated around the footings. It should be noted, however, that the ultimate decision to fish in the vicinity of subsea obstructions outside of safety zones lies with the skipper of a vessel.

Interference to Fishing Activities

The potential for interference to fishing activities as a result of partial removal of the Murchison jacket is detailed within Table 11.6. The number of days the decommissioning vessels will be on site to partially remove the Murchison jacket is low (31 to 60 days; SFF, 2012), with the partial removal of the Murchison jacket via BTA incurring the highest number of vessel days required to transit to and from the site (60 days; SFF, 2012). Due to the low number of days decommissioning vessels can potentially interfere with fishing activity, the magnitude of effect is considered to be low to minor depending on removal method (Table 11.2). The potential to interfere with fishing activity (significance of effect) is considered minor (Table 11.6).

Table 11.6: Impact significance of interference to fishing activities – partial removal of jacket

Impact	Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Effect
Interference to fishing activities resulting from partial removal of the Murchison jacket using conventional HLV	Fixed gear vessels	Low	Low	Minor
Interference to fishing activities resulting from partial removal of the Murchison jacket using single lift vessel	Fixed gear vessels	Low	Low	Minor
Interference to fishing activities resulting from partial removal of the Murchison jacket using small crane vessel	Fixed gear vessels	Low	Low	Minor
Interference to fishing activities resulting from partial removal of the Murchison jacket using BTA	Fixed gear vessels	Low	Medium	Minor

Damage to or Loss of Gear

The potential for damage or loss of fishing gear as a result of partial removal of the Murchison jacket is detailed within Table 11.7. After decommissioning, the remaining platform footings will cover a very discrete area of the seabed (0.0018 n miles^2), however due to the footings extending 32 to 44 m from the seabed it is considered that vessels towing demersal gear have the potential to snag and the magnitude of effect on these vessels is considered to be medium.

Table 11.7: Impact significance of damage to of loss of gear – partial removal of jacket

Impact	Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Effect
Damage or loss of gear due to partial removal of the Murchison jacket.	Demersal vessels	Medium	Medium	Moderate
	Pelagic vessels	Medium	Low	Minor
	Fixed gear vessels	Low	Negligible	Not significant

11.3.2 Pipeline PL115 Decommissioning

Interference to Fishing Activities

The potential for interference to fishing activities as a result of pipeline decommissioning is detailed within Table 11.8.

The number of days the decommissioning vessels will be on site to decommission pipeline PL115 by burying exposed sections of the pipeline, removing the spools and burying the pipeline ends is very low (8 days; SFF, 2012).

Due to the very low number of days decommissioning vessels can potentially interfere with fishing activity, the magnitude of effect is considered to be negligible (Table 11.2). The potential to interfere with fishing activity (significance of effect) is considered not significant (Table 11.8).

Table 11.8: Impact significance of interference to fishing activities – pipeline decommissioning

Impact	Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Effect
Interference to fishing activities resulting from burying exposed sections by rock-placement, removing spools and burying ends	Fixed gear vessels	Low	Negligible	Not significant

Damage to or Loss of Gear

It is considered that burial of exposed sections of pipeline PL115 by rock-placement, removing spools and burial of ends would not result in any long-term legacy socioeconomic impacts to fishing activities as the pipeline would no longer pose a snagging risk to fishing gear. Rock-placement is a standard industry mitigation to leave pipelines over-trawlable. Rock-placement would be installed with graded rock to the optimum angle to allow trawls to roll over the top. The impact is therefore not considered to be significant for all fisheries.

11.3.3 Bundle Decommissioning

The potential for interference to fishing activities as a result of full removal of the bundles is detailed within Table 11.9. Due to the low number of days (30.4) decommissioning vessels can potentially interfere with fishing activity, the magnitude of effect is considered to be low.

Table 11.9: Impact significance of interference to fishing activities – full removal of bundles

Impact	Receptor	Sensitivity of Receptor	Magnitude of Effect	Significance of Effect
Interference to fishing activities resulting from full removal of bundles	Fixed Gear Vessels	Low	Low	Minor

Damage to or Loss of Gear

Complete removal of bundles PL123, PL124 and PL125 would mean that they would no longer pose snagging risks to vessels. The impact is therefore considered to be not significant for all fisheries.

11.3.4 Drill Cutting Pile Decommissioning

The Murchison drill cuttings pile is currently located within the footprint of the jacket footings and is therefore protected by the footings from potential interactions with fishing gear.

Field studies designed to trawl over a known cuttings pile and measure the dispersion of cuttings resulting from the trawling activities were conducted by the Fisheries Research Services in 2000. The results indicated that trawling activity disturbed relatively little material to a significant height into the water column. Contamination would be spread by trawling activities, but not in amounts or at rates that are likely to pose serious wider contamination or toxicological threats to the marine environment (OSPAR, 1999). Therefore, fishing gear interactions with the redistributed cuttings pile would be unlikely to result in an impact to the sediments and commercial fishing, the severity of which would only be slight, and therefore would not present a significance risk.

Studies conducted by UKOOA have shown that catches close to the cutting piles have about the same level of hydrocarbons and other contaminants in their tissues as catches from those away from the platforms (UKOOA, 2002). In contrast, SFF have reported that decommissioning trawlsweeps undertaken over the Hutton TLP cuttings pile resulted in the gears and doors (starboard and port) being covered in a muddy substance with a very strong oily smell (SFF, 2003).

11.4 Mitigation

The UK Hydrographic Office and Kingfisher will be informed of all decommissioning activities and any subsea structures that are left in place that could represent a snagging risk to fisheries activities. CNRI will establish lines of communication to inform other sea users, including fishermen, of vessel operations during decommissioning activities.

The number of vessels travelling to or standing by Murchison will be kept to the minimum.

11.5 Residual, Cumulative And Transboundary Impacts

Residual impacts are considered to be those which after mitigation measures have been applied, record a significance rating of moderate or above. The residual impacts are:

- Potential damage or loss of demersal fishing gear as a result of partial removal of the jacket.

- Interference to fixed gear fishing activities as a result of the decommissioning traffic associated with burying exposed sections of pipeline PL115 by trenching, removing spools and burying ends.

There are a number of oil and gas infrastructures in the North Sea which could potentially undergo decommissioning during the timescale of the Murchison Platform and associated pipelines decommissioning. There is also potential for construction activities to occur in the area as a result of oil and gas exploration.

The timescale of any potential developments and other decommissioning projects in the North Sea are not currently available and therefore it is not possible to assess the scale of cumulative socioeconomic impacts of the Murchison Platform and associated pipelines. It is considered that the decommissioning project may contribute to an overall cumulative socioeconomic impact.

11.6 Conclusions

There will be minor impact to fishing activities during the decommissioning operations in the Murchison area. This impact will be reduced by minimising the number of vessels travelling to, or standing by, Murchison once it has been decommissioned. Potential damage or loss of demersal fishing gear as a result of the partial removal of the jacket will be minimised by notifying the appropriate organisations of any subsea structures left in place after decommissioning.

12.0 WASTE

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, some activities will involve the manual removal of all accommodation infrastructure and chemicals stored within the offshore structure, whereas other activities will involve 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 Murchison Facilities are:

- The generation of large quantities of controlled waste within short timeframes which requires detailed planning to manage the logistics associated with the transport to shore, temporary storage and onward treatment/disposal of materials.
- The potential for large quantities of so-called "problematic" materials to be generated due to the cross–contamination of non-hazardous waste with substances that have hazardous properties that result 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 affirms that the disposal of such installations should be governed by the precautionary principle, CNRI will assume the worst case, especially when dealing with hazardous and unidentified wastes, and choose waste treatment options in accordance with the Waste Management Strategy (Section 12.3.1).

12.1 Waste Generation

Typical non-hazardous waste will include scrap metals, concrete, plastics and wood that are not cross-contaminated with special waste and can therefore be removed and recovered for reuse or recycling. Special waste will include 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 4:

- topsides decommissioning (Table 4.3);
- Murchison jacket (Table 4.4);
- materials associated with pipeline and bundles decommissioning (Table 4.5), and
- materials associated with platform well decommissioning (Table 4.6).

12.1.1 Radioactive Waste

Radioactive wastes including sources (pile densitometer sources) and NORM (for example pipework and sand from vessels) will be managed in line with current legislative requirements (Appendix B). The Radioactive Substances Act 1993 Amendment (Scotland) Regulations 2011 regulates the handling, storage, transfer and disposal of such waste. CNRI has an existing procedure in place for managing radioactive waste and the local rules for working with radioactive materials will be revised to include the removal and transportation of radioactive materials during decommissioning in consultation with the Scottish Environment Protection Agency (SEPA).

12.1.2 Wastes Generated During EDC

Post CoP, cleaning of the Murchison topsides will be required during the EDC phase to remove hydrocarbons, NORM, process chemicals, sand scale, sludge and other contaminants from within process systems prior to the module separation activities. While the base case scope for this cleaning is for no deep cleaning activities to be undertaken offshore, the removal of sludge and sand from vessel internals will be required to reduce the possibility of a significant recharge of the process systems with residual hydrocarbons.

Draining, Flushing Purging and Venting

During the EDC phase, the Murchison topsides' process and utilities system vessels and pipework will be drained, flushed, purged and vented. These initial cleaning activities will remove gross hydrocarbons liquids, chemicals, gases and other hazardous inventories from the system. Where necessary, bulk loose deposits (sand, sludge, etc.) will be removed from major vessels.

The disposal route proposed for all effluent arising from the drain-down and flushing of hydrocarbon systems is via the closed drains system to the oil surge tanks. The disposal route proposed for effluent arising from the drain down and flushing of hydrocarbon systems is via the closed drains system to the oil surge tanks. The disposal of these fluids from the oil surge tanks will be subject to detailed design and engineering and managed in accordance with appropriate legislation. In addition, these fluids will be handled in line with the Waste Management Strategy (Section 12.3.1).

After this initial flushing, draining, purging and venting phase, residual hydrocarbons and contaminants will remain *in situ* until removal at a fully-permitted onshore disposal facility. The residual contaminants will not be free fluids and will be fully contained to prevent any leaks during transit.

12.1.3 Disposal of Marine Growth

An assessment of marine growth concluded that the Murchison platform jacket supports an extensive cover of marine growth (Section 5); BMT Cordah, 2010). This marine growth could be removed offshore and disposed at sea or inshore and composted, used as a fertilizer and/or sent to a landfill.

Prior to jacket removal, a study assessing the options for managing marine growth removal offshore and its disposal onshore will be undertaken with the following objectives:

- to characterise and compare the key attributes of onshore/offshore removal options on the basis of environmental and technical criteria;
- to assess the risk of introducing alien invasive species to coastal areas; and
- to investigate potential odour issues at decommissioning yards and identify measures to avoid or mitigate if required.

CNRI have undertaken consultation with JNCC regarding the presence of *L. pertusa* on the legs of the Murchison platform and requested advice from JNCC with regard to the definition of ‘significant’ growth that would trigger the requirement for an Appropriate Assessment. JNCC advised that as *L. pertusa* would not have occurred without the presence of the platform, mortality as a result of decommissioning operations would not be considered as an issue of significant concern for the EIA.

12.2 Regulatory Requirements and Corporate Standards

There is no waste related legislation that specifically covers decommissioning activities, but some aspects of existing 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”.

It is the responsibility of the producer or duty holder to decide whether a substance or object is waste. 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 generated is then governed by a number of regulations. CNRI have prepared a Permits, Licences, Authorisations, Notifications and Consents (PLANC) register of legislation for decommissioning, including relevant waste legislation.

12.2.1 Corporate Standards

CNRI's Safety, Health and Environmental Management System (SHEMS) provides a means to comply with SHE legislation and industry standards, manage SHE risks in the business and deliver continual improvement in SHE performance.

CNRI recognise that the waste management activities arising from decommissioning will have associated SHE risks and will therefore ensure that the identification, control and minimisation of these risks is addressed as part of the Company's SHE risk management process, for example through the CA and HAZID processes.

12.3 Waste Management

The DECC Guidance Notes (2011b) 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 CNRI intends to implement the waste hierarchy is included in the Decommissioning Programme for the Murchison Facilities.

An extensive review of the Murchison Facilities equipment and components undertaken by CNRI identified over 500 items that could possibly be reused (CNRI 2011d). CNRI have concluded that none of these items could be used on other CNRI assets, and so they will be sold for reuse, either directly by CNRI, through a platform broker, or through the decommissioning contractor.

Non-hazardous materials, such as scrap metal, concrete, plastics and wood 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 Murchison topsides, jacket, pipelines, bundles and well abandonment. Recycling is therefore expected to be the most significant end point for materials recovered from the Murchison Facilities (Table 12.1).

Where necessary, hazardous waste resulting from the dismantling of the Murchison Platform shall be pre-treated to reduce its hazardous properties or, in some cases, render it non-hazardous prior to recycling or landfilling. Under the Landfill Directive, pre-treatment will be necessary for most hazardous wastes which are destined to be disposed of to landfill sites. Other non-hazardous waste which cannot be reused or recycled will be disposed of to a landfill site.

Table 12.1: Fate of Waste

Facility	Recommended decommissioning option	Total weight of waste by type (t)	% of waste produced**
Wells (x33)	P&A and conductor recovery	Metals – 7,423	96%
		Non-hazardous - 297	
Topsides	Full removal	Metals – 21,653	93%
		Plastics – 1,228.1	
		Wood – 8.2	
		Non-hazardous – 294	
		Hazardous (special) – 1,400	
Jacket	Partial removal	Metal – 1,302	58%
		Wood - 40	
		Marine growth - 963	
Pipeline PL115	Burial (removal of mattresses)	Non-hazardous - 320	0%
Bundles PL123, PL124, PL125	Full removal	Metals - 580	100%*
Subsea wellheads	Full removal	Metals - 100	100%*

*Based on the values provided within Section 4, which identifies negligible quantities for other materials.

**The percentages do not include the footings

Source: CNRI (2011b)

12.3.1 Waste Management Strategy

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

12.3.2 Environmental Management System

The management of waste generated from operations and drilling activities is already addressed by CNRI through an ISO14001 certified Environmental Management System (EMS) (Section 14). The EMS includes a documented procedure for waste management which is designed to ensure that all waste generated during CNRI's offshore production and drilling operations are managed according to the Company's SHE policy and relevant legislation.

Specifications to manage the waste generated during decommissioning will conform to the requirements of CNRI's EMS. In order to achieve this it will be necessary to:

- Undertake a review of the EMS and update it to ensure that significant environmental impacts and legislative requirements as a result of waste generation and treatment during decommissioning are adequately recorded and assessed, and any requirements for operational controls or other management actions are identified.
- Prepare a WMP for individual decommissioning projects.

12.3.3 Murchison Facilities Waste Management Plan

A Murchison Facilities Waste Management Plan (MFWMP) will be developed to translate the WMS into individual project plans with defined actions, roles and responsibilities. The scope of the MFWMP will cover the decommissioning programme for the selected removal options and disposal routes.

The aims of the MFWMP will be to provide a comprehensive source of information on waste management for the Murchison decommissioning project, to provide information and data to illustrate management system control and an auditable trail for legislative compliance.

The MFWMP will be a written plan and be maintained as a controlled document. It will include and reference other project documents, plans and procedures, such as project risk management plans and change control procedures.

The onshore location for dismantling and disposal of wastes from the Murchison 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 CNRI.

Although CNRI will not be undertaking the actual physical work, the legal liability, i.e. Duty of Care, for all waste generated from decommissioning remains with CNRI throughout all these activities.

The selection and management of contractors by CNRI is managed through the contractor control processes and procedures. Specific actions to support the management and minimisation of waste generated by contactors during decommissioning will include:

- Ensuring that waste management issues are included during the contract procurement process, for example consideration of contractor past SHE performance, during the procurement process.
- Ensuring that waste management issues are covered within the contractor interface documents, for example SHE performance measurement including waste key performance indicators (KPIs) and competency training.
- Engaging with contractors to identify effective technical solutions that support waste minimisation with the reuse and recycling of waste, if possible.

The procedures and processes for waste and contractor management will be embedded in the EMS with the MFWMP detailing actions, roles and responsibilities of personnel from within CNRI and the various contractors working on an individual decommissioning project.

12.3.5 Measuring and Monitoring Performance

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

- 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.

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13.0 ACCIDENTAL EVENTS

Throughout the decommissioning programme CNRI will ensure that all parties adhere to the CNRI Infield Safety Procedures. However, in the event of an accidental event CNRI have a number of mitigation strategies to ensure that the impact to the environment is reduced as far as is reasonably practicable.

Three types of accidental event present the most likely worst case impacts to the environment:

- hydrocarbon release;
- chemical spill; and
- dropped objects.

These events will be discussed in further detail and strategies to prevent or limit their impact presented. During the decommissioning process minor spills such as leaks, loss of fluid from machinery or hoses on the platform will be addressed through the on-site implementation of CNRI's Infield Safety Procedures. This type of minor accidental event has been excluded from this assessment.

13.1 Hydrocarbon Release

Hydrocarbon spills can occur from a range of sources and can result in a number of different hydrocarbon types being spilt to the marine environment. Hydrocarbon spills include diesel, crude oil, condensate and gas.

13.1.1 Background

All offshore activities carry the potential risk of a hydrocarbon loss to the sea. During the period from 1975 to 2005, a total of 16,930 tonnes of oil were discharged from 5,225 individual spill events in the UKCS (UKOOA, 2006). Analysis of spill data between 1975 to 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). Oil spill occurrence in the UKCS rose from 1975 to 2005 with increased oil and gas activity. Since 2005, the number of oil spills and the amount of oil spilt in the UKCS annually has remained relatively constant. Figure 13.1 shows both the amount of oil spilled and the total number of spills recorded annually (regardless of spill size i.e. < 1 tonne) in the UKCS between 1991 and 2011 (DECC, 2013).

Potential Sources of Impact

The potential sources for hydrocarbon spillages from the Murchison Facilities have been identified through an Environmental Impacts Identification workshop, HAZIDs and the knowledge and experience developed from CNRI and oil and gas industry operations in the North Sea. Based on this knowledge the following scenarios have been identified:

- sinking of a vessel due to collision, releasing diesel to the sea;
- worst case diesel spill from a vessel;
- loss of fluids from subsea or topsides;

- accidental fuel (diesel or aviation) spillage during refuelling; and
- diesel tank remedial loss.

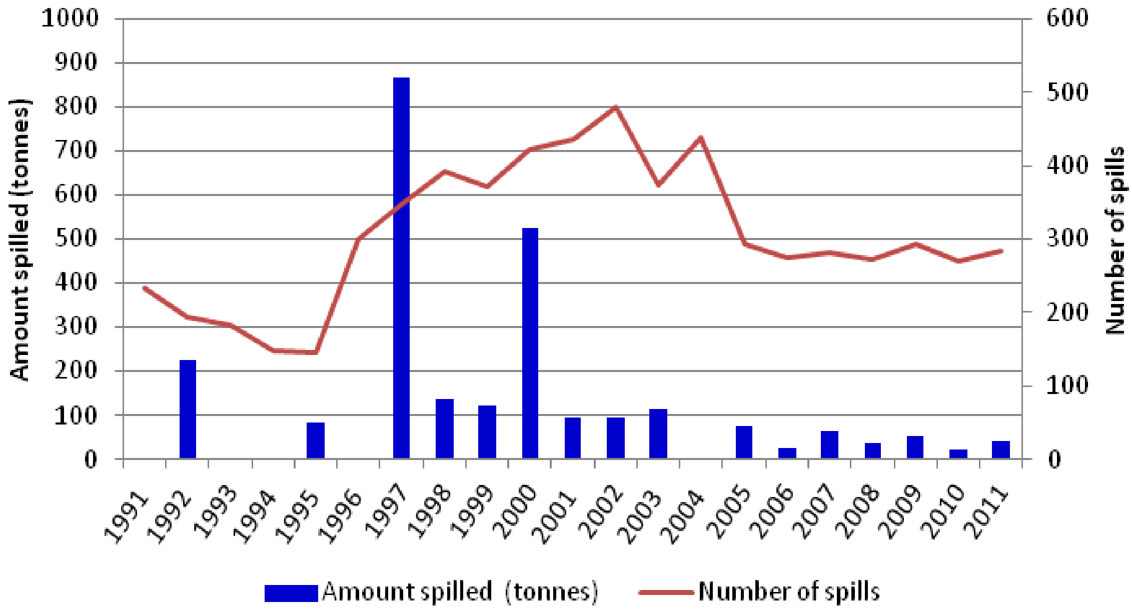

Figure 13.1: Number of spills and spill amounts on the UKCS annually between 1991 and 2011

Source (DECC, 2013)

Behaviour of Oil at Sea

When oil is released to the sea, it is subjected to a number of processes including: spreading, evaporation, dissolution, emulsification, natural dispersion, photo-oxidation, sedimentation and biodegradation (Table 13.1).

The processes of spreading, evaporation, dispersion, emulsification and dissolution are most important early on in a spill whilst oxidation, sedimentation and biodegradation are more important later. The behaviour of crude oil released at depth will depend on the immediate physical characteristics of the release and on subsequent plume dispersion processes (DTI, 2001).

Hydrocarbon Properties

The fate and effect of a spill is dependent on the chemical and physical properties of the hydrocarbons. Hydrocarbons used in, or produced by, the Murchison Field include diesel, aviation fuel and Murchison crude. The Murchison crude has a specific gravity of 0.84, and is classified as an ITOPF Group II oil. This indicates the oil will remain afloat on the sea surface in the event of a spill to sea.

Diesel and aviation fuel have very high levels of volatile components, evaporating quickly on release. The low asphaltene content in the diesel and aviation fuel 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 in comparison with the risks posed from a spill of Murchison Field crude oils.

Table 13.1: Overview of the main weathering fates of oil at sea

Weathering Process	Description
Evaporation	Lighter components of oil evaporate to the atmosphere.
Dispersion	Waves and turbulence at the sea surface can cause a slick to break up into fragments and droplets of varying sizes which become mixed into the upper levels of the water column.
Emulsification	Emulsification occurs as a result of physical mixing promoted by wave action. The emulsion formed is usually very viscous and more persistent than the original oil and formation of emulsions causes the volume of the slick to increase between three and four times and slows and delays the other processes which cause the oil to dissipate.
Dissolution	Some compounds in oil are water soluble and will dissolve into the surrounding water.
Oxidation	Oils react chemically with oxygen either breaking down into soluble products or forming persistent tars. This process is promoted by sunlight.
Sedimentation	Sinking is usually caused by the adhesion of sediment particles or organic matter to the oil. In contrast to offshore, shallow waters are often laden with suspended solids providing favourable conditions for sedimentation.
Biodegradation	Sea water contains a range of micro-organisms that can partially or completely breakdown the oil to water soluble compounds (and eventually to carbon dioxide and water).

Source: (DTI, 2001)

Assessment of Impact

An accidental release of hydrocarbons can result in a complex and dynamic pattern of pollution distribution and impact in the marine environment. As there are a variety of natural and anthropogenic factors that could influence an accidental spill, each spill is unique. Long-term effects reported from such accidents range from none detected (e.g. after the Ekofisk blowout in 1977) to chemical contamination but no acute biological effects detectable (e.g. after the wreck of the Braer in 1993) (DTI, 2001). The environmental impact of a spill depends on numerous factors including:

- location and time of the spill;
- spill volume;
- hydrocarbon properties;
- prevailing weather/metocean conditions;
- environmental sensitivities; and
- efficacy of the contingency plans.

Overview of Modelling Undertaken for Current Operational Conditions

Oil spill modelling has been undertaken for the Murchison Field, and included within the Murchison Platform Oil Pollution Emergency Plan (OPEP). Worst case volumes of Murchison crude modelled for accidental spills during the production phase totalled 2,145 m^3 for the Murchison export pipeline to the Dunlin. As no crude will be present at the Murchison Platform during decommissioning operations, this far exceeds the volume of potential loss during the proposed decommissioning programme.

Modelling was undertaken for a worst case production event, the accidental loss of 1,088 m^3 of diesel from the platform. The modelling results for this discharge predicted that the diesel would persist for 8 to 9 hours before dispersing naturally into the environment. At the end of the model run the spill had a length of 3 km and a width of 0.4 km. Results indicated that 423 m^3 of the hydrocarbon evaporated and 665 m^3 dispersed into the upper layers of the water column. It is estimated that the impact to marine biological resources would be localised and those impacted are likely to be subjected to toxic short term non-persistent effects. The volume of diesel likely to be present during the proposed decommissioning operations will exceed the modelled amount; however, the Murchison Platform OPEP and oil spill modelling will be updated to reflect the change in operations and activities at the field associated with decommissioning.

13.1.2 Methodology

The key regulatory drivers that assist in reducing the consequences of potential oil or chemical releases are summarised below:

- International Convention on Oil Pollution Preparedness, Response and Cooperation 1990 requires that Operators of offshore installations under UK jurisdiction have OPEPs which are coordinated with UK National Contingency Plan.
- Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 (as amended) require that every offshore installation and oil handling facility must have an approved OPEP setting out arrangements for responding to incidents which cause or may cause marine pollution by oil, with a view to preventing such pollution or reducing or minimising its effect. The regulations also require that 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.
- Offshore Installations (Emergency Pollution Control) Regulations 2002 require OPEPs to contain arrangements for the potential involvement of the Secretary of State’s Representative for Maritime Salvage and Intervention in an incident.
- EC Directive 2004/35 on Environmental Liability with Regard to the Prevention and Remedying of Environmental Damage enforces strict liability for prevention and remediation of environmental damage to “biodiversity”, water and land from specified activities.

13.1.3 Impacts on Sensitive Receptors

Biological Receptors

Although the likelihood of a hydrocarbon spill from the Murchison Facilities is remote, there is a potential risk to organisms in the immediate marine environment if a spill were to occur. The following section highlights biological receptors that may be impacted from a potential oil spill incident. Table 13.2 summarises the effects of oil spills to marine life from the Murchison

Facilities. As the majority of potential spills are likely to be on the surface and any subsea release will result in localised oil rising through the water column to the surface, both planktonic and benthic communities are less likely to be influenced by an accidental spill from the Murchison Facilities. Other communities including fish, birds and marine mammals may incur more significant impacts. For a full description of the environmental sensitivities in the Murchison area refer to Section 5.

Table 13.2: Summary of potential impacts to main biological receptors

Biological Receptor	Effects and Communities at risk
Plankton	Localised effects due to toxicity. Impacts on communities are difficult to measure due to natural variability, high turnover and seasonal fluctuation.
Benthos	Usually only localised effects from toxicity and smothering, and only if oil reaches the seabed. Benthic communities may be affected by gross contamination, with recovery taking several years. Mortality will be dependent on oil sensitivity leading to structural change in the community. The most numerically dominant species identified in all surveys were polychaete worms. The dominant habitat recorded in the area is offshore circalittoral sand with the predominant biotope being *SS.SCS.OCS.GlapThyAmy* (Connor *et al*., 2004). Murchison site surveys indicate that seabed sediments beyond approximately 500 m are considered representative for the northern North Sea region (Section 5).
Fish, spawning and nursery grounds	Adult fish are expected to avoid the affected area, but if they are affected, the hydrocarbons may result in tainting the fish, and hence in a reduction of its commercial value. Eggs and larvae may be affected, but such effects are generally not considered to be ecologically important because eggs and larvae are distributed over large sea areas. Demersal species may be influenced by habitat pollution. The Murchison Field lies within spawning grounds for five species between January and June. A total of seven species have nursery areas within the Murchison area with these areas are utilised by some species all year round. (Section 5).
Seabirds	Physical fouling of feathers, damage to eyes and toxic effects of ingesting hydrocarbons can result in direct and indirect fatalities. Effects will depend on species present, their abundance, reliance on particular prey species and the time of year. Diving birds such as auks and gannets are particularly susceptible. Species most affected are those such as guillemots, razorbills and puffins that spend large periods of time on the water, particularly during the moulting season when they become flightless (DTI, 2001). The most sensitive times of year for birds in the Murchison area (Block 211/19 and surrounding blocks) are March, July, October and November when vulnerability to oil pollution is “high” in some of the area. Vulnerability ranges from “moderate” to “low” for the remainder of the year. Overall seabird vulnerability in the Murchison area is “low” (Section 5).
Marine mammals	Potential effects include inhalation of toxic vapours, eye/skin irritation and bioaccumulation. Ingestion of oil can damage the digestive system or affect liver and kidney function. Loss of insulation through fouling of the fur of young seals and otters increases the risk of hypothermia. Oil contamination can impact food resources directly through prey loss or indirectly through bioaccumulation. Species observed in the Murchison area are sperm whale, minke whale, long-finned pilot whale, killer whale, white-beaked dolphin, white-sided dolphin and harbour porpoise, with most sightings occurring in the summer months. The Murchison Field is 240 km from the nearest coastline. It is therefore unlikely that significant numbers of grey and harbour seals or otter would be found there (Section 5).

Table 13.2 (continued): Summary of potential impacts to main biological receptors

Biological Receptor	Effects and Communities at risk
Protected habitats and species	There are no Annex I habitats found in the area. This includes Annex I Submarine structures made by leaking gases, pockmarks, methane-derived authigenic carbonate (MDAC) derived outcrops, bubbling reefs and Annex I Reefs such as stony, bedrock or biogenic reefs. Of the Annex II species listed in Section 5, the only species sighted within the Murchison area is the harbour porpoise which has been sighted in very high numbers in February and July and in low numbers in May, June, August and September (UKDMAP, 1998; Section 5).

Source: JNCC (1999), DTI (2001), SMRU, (2001).

Shoreline Impact

The results of the oil spill modelling for the operational Murchison platform do not predict that diesel spills will reach either the UK or the Norwegian coastline. Murchison crude model predictions for the operational Murchison platform indicate that under favourable conditions oil would beach along the Norwegian coast or the Shetland Islands. However, during the decommissioning operations the actual volume of hydrocarbons remaining on the platform would be residual and therefore the likelihood of this occurring is negligible.

Socioeconomic Receptors

A number of sectors may be influenced by a potential spill from the Murchison Facilities. Table 13.3 describes the main socioeconomic receptors that will be affected by the decommissioning operations.

Table 13.3 Summary of main socioeconomic receptors

Receptor	Risks and Status at the Murchison Facilities
Fisheries	Fishing is one of the primary economic activities in the EU and it supports other shore-based activities including fish processing and boat construction. The impacts to offshore fishing are limited for the period that oil remains on the surface as access to fishing grounds would be limited. There is the potential for fish that come into contact with oil to become tainted precluding sale. There is no UKCS evidence of any long-term effects of oil spills on offshore fisheries. The relative UK fishing effort in the Murchison area (ICES rectangles 51F1 and 52F1) in 2010 was “very low” in comparison with other areas of the North Sea. In ICES rectangles 51F1 in 2010, the “relative value” was “low” for demersal fisheries, “very low” for pelagic, “very low” for *Nephrops* and shrimps and shellfish and “low” overall (Section 5).
Tourism	Coastal tourism can be adversely affected by oil pollution events owing to reduced amenity value. Impact can be further influenced by public perception and media coverage. The location of Murchison suggests that there is unlikely to be any impact on tourism.
Shipping	The Murchison Field is located in an area of low to high shipping activity (Anatec, 2012). There are four shipping lanes in the vicinity of the adjacent Block 211/29 and an average of 0.5 to 10 vessels per day are known to use each shipping lane (DTI, 2001) (Section 5). Shipping lanes are used by shuttle tankers, supply and standby vessels serving the offshore oil installations in the area. Although all of the above may potentially be impacted by an oil spill, the impacts will likely last only whilst there is oil on the sea surface, as this may restrict access. However, it is unlikely that there will be any long-term socioeconomic impacts on this industry

Table 13.3 (continued): Summary of main socioeconomic receptors

Receptor	Risks and Status in the Murchison Facilities
Oil & Gas	The oil and gas industry is well established in the North Sea, supporting the UK and Norwegian economies in particular. Although the receptors discussed above may potentially be impacted by an oil spill, the impacts will likely last only whilst there is oil on the sea surface, as this may restrict access. However, it is unlikely that there will be any long-term socioeconomic impacts on this industry.

13.1.4 Mitigation

Mitigation and management first focus on preventing or minimising the probability of an accidental spill and then reducing the consequences of the event through optimum and efficient containment and response to a release. During decommissioning, minor non-routine and emergency events such as minor leaks, drips and spills from machinery and hoses on the platform, vessels or at onshore sites, could cause a localised impact. The accidental release of small quantities of oil would be minimised as far as possible through appropriate management procedures and mitigation measures. The effects of such releases could be rectified quickly on site and they would be managed through vigilance, operational, inspection and emergency procedures, and specific safeguards such as on-site clean-up equipment and containment measures. For these reasons, such minor events have been excluded from this assessment as they will be managed under ‘normal’ operational procedures and controls.

The response to all spills is detailed in the OPEP; however the worst case scenario, namely collision or complete loss of fuel inventory from a vessel, will be investigated further. Table 13.4 lists the planned measures to prevent or reduce the likelihood of a spill occurring during decommissioning of the Murchison Facilities. Based on the estimated volumes of diesel and Murchison crude, CNRI’s response capability for both counter pollution and containment are capable of providing an appropriate level of response to a spill resulting from the Murchison platform and associated subsea infrastructure during the decommissioning operations.

Table 13.4: Spill preventative measures for likely scenarios during decommissioning

Activity	Preventative Measures
All spills	Adherence to CNRI Infield Safety Procedures. The Murchison Field Oil OPEP has been produced in accordance with the Merchant Shipping (Oil Pollution Preparedness, Response & Co-operation Convention) Regulations 1998 and the Offshore Installations (Emergency Pollution Control) Regulations 2002. The OPEP details responsibilities for initial response and longer term management (SHE-PRO-903, OPS-PRO-1009), and will be updated to reflect the change in operations and activities associated with decommissioning. There are three planned levels of response, depending on the size of the spill: • Tier 1 - standby vessel equipped with dispersants and spraying equipment; • Tier 2 - air surveillance and dispersant spraying through Oil Spill Response Ltd. (OSRL); and • Tier 3 - clean-up equipment and specialist staff available through OSRL. In addition, CNRI have specialist oil spill response services provided by OSRL and are members of the Oil Pollution Operator’s Liability Fund (OPOL).

Table 13.4 (continued): Spill preventative measures for likely scenarios during decommissioning

Activity	Preventative Measures
Vessel collision	Local shipping traffic would be informed of proposed decommissioning activities and a standby/support vessel would monitor shipping traffic at all times.
Spill beyond the 500 m exclusion zone	In the event of an accidental spill to sea, vessels will have their own shipboard oil pollution emergency plan (SOPEP) and access to CNRI's OPEP and equipment.

The Murchison decommissioning programme would not significantly increase the overall level of risk of an oil spill as a result of a vessel collision, due to the very low probability of an incident occurring. The mitigation measures and contingency plans in place would consider all foreseeable spill risks and would ensure that the spill risk is reduced to as low as reasonably practicable. The contingency plans would ensure that an appropriate response is made to any spill in order to minimise any impact on the environment.

13.1.5 Residual, Cumulative and Transboundary Impacts

Residual Impacts

During removal operations, the loss of residual fluids contained within pipework, tanks and storage sumps may cause a localised deterioration in water quality. CNRI will ensure that pipework, sumps and tanks in the topsides are emptied and cleaned during the EDC phase, and, if necessary, temporarily seal the cut ends of process pipework before the modules are lifted off (Sections 4 and 12). Any vessel receiving or handling modules or components from the topsides will be equipped with its own SOPEP to deal with minor releases and will have access to CNRI's OPEP and equipment.

The residual risk of environmental impact from accidental oil spills during decommissioning of the Murchison Facilities will be reduced to levels that are as low as reasonably practicable. This will be achieved by the preventive measures incorporated during design, operational control procedures and training. Even with these in place, there will still be a residual, albeit very low, risk of marine and coastal environmental and socioeconomic impact.

Cumulative Impacts

Cumulative impacts occur as a result of a number of activities, discharges and emissions potentially combining to create a significant impact. Cumulative effects arising from the Murchison Facilities have the potential to act additively with those from other oil and gas activity, including both existing activities and new activities, or to act additively with those of other human activities (e.g. fishing and marine transport of crude oil and refined products etc.) (DTI, 2004).

Cumulative impacts would most likely occur from the nearby Magnus, Thistle A, Dunlin A and Brent A platforms (Figure 4.1) or from additive decommissioning impacts.

Any hydrocarbon discharge as a result of the decommissioning activity would be expected to disperse rapidly in the immediate environment without the potential to combine with other discharges from concurrent incidents. It is difficult to predict whether or not the impacts from an oil spill to the marine ecology of the affected area would be cumulative. This would depend on previous disturbances or releases at specific locations. Cumulative effects of overlapping "footprints" for detectable contamination or biological effects are considered to be unlikely. No significant synergistic effects are currently identified (DTI, 2004).

Transboundary Impacts

There is a very high probability that a hydrocarbon spill would cross into the Norwegian sector. It is likely that even a Tier 1 spill may cross the median line. Modelling predicts a diesel spill will cross the median line within 40 minutes, but not reach the coast. Despite the likelihood of a transboundary impact, the probability of a Tier 2 or Tier 3 spill remains low and is considered to be insignificant.

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 have agreements with equivalent organisations in other North Sea coastal states, under the Bonn Agreement 1983. Applicable international arrangements are further described in Appendix A.

13.1.6 Conclusions

The conclusions from an impact assessment for an accidental hydrocarbon release include:

- Worst case scenario for hydrocarbon release for the Murchison Facilities would result from a complete loss of fuel inventory from on-site vessels or collision.
- Diesel spills will disperse and dilute quickly, with no impact to coastline.
- Probability of a hydrocarbon spill occurring is low and does not contributes to the overall spill risk in the area.
- Murchison OPEP response will ensure that all hydrocarbon spoils are dealt with efficiently.

13.2 Chemical Release

An accidental release of chemicals can result in a complex and dynamic pattern of pollution distribution and impact to the marine environment. The number of factors that could influence an accidental spill, both natural and anthropogenic, render each one unique. Potential sources of impact will be discussed, with a review of the sensitive receptors that may be influenced. In many cases these impacts and receptors have been detailed in the hydrocarbon release section (Section 14). Where chemical release differs, the impacts will be discussed in further detail.

13.2.1 Methodology

As part of the decommissioning process it is important to consider the magnitude of a potential chemical spill and critically to assess the effects of such an unplanned event on key sensitive receptors. The key regulatory drivers that assist in reducing the consequences of potential chemical releases are summarised in Section 13 with the addition of the Offshore Chemical Regulations 2002 (as amended).

These regulations require a permit to be issued from the regulatory body which covers discharges of chemicals during decommissioning operations (PON15E). The permit should include a detailed chemical risk assessment to evaluate the potential environmental impact of any chemical discharges. Site specific risk assessments will be undertaken for the use and discharge of chemicals used during Murchison decommissioning, for the preparation of the relevant PON15 permit application under the Offshore Chemicals Regulations 2002 (as amended).

13.2.2 Potential Sources of Impact

Technical failure remains the leading cause of chemical spills in the North Sea. The primary sources of loss to the environment are from spills of hydraulic fluids or chemicals. The potential sources of chemical spillages from the Murchison Facilities have been identified through the Environmental Impacts Identification workshop, HAZIDs and the knowledge and experience developed from CNRI and oil and gas industry operations in the North Sea. Based on this knowledge the following scenarios have been identified:

- Loss of fluids from bunkering operations.
- Loss of fluids from subsea or topsides removal.

13.2.3 Impacts on Sensitive Receptors

The release of chemicals to the environment may impact sensitive receptors in different ways, depending on the following factors:

- volume of the spill;
- depth of loss;
- chemical toxicity;
- chemical solubility;
- persistence in the environment;
- biodegradability of the compound;
- potential for bioaccumulation in the food chain; and
- partitioning of individual components.

Biological Receptors

For a comprehensive description of biological receptors in the Murchison area sensitive to potential chemical spills see Section 5 and Table 13.2. Due to the rapid dispersion and dilution of chemicals upon discharge, few biological receptors face a noticeable impact. The most sensitive receptors are the planktonic communities.

Plankton (phytoplankton, zooplankton and fish larvae) are likely to come into direct contact with discharged chemicals, with zooplankton appearing to be the most vulnerable particularly at the early stages of development. However, the impact of a chemical spill is not likely to impact beyond the immediate vicinity of the discharge point because:

- The likely credible maximum volume of chemicals that may be subject to a spill event will be very low.
- Discharge is likely to be dispersed and diluted rapidly by the receiving environment.
- Many of the compounds are volatile or soluble and are removed from the water by evaporation and dilution.
- BOD is likely to be within the capacity of ambient oxygen levels.

Socioeconomic Receptors

Table 13.3 lists the main socioeconomic receptors that are relevant to a hydrocarbon spill. In most cases the information is also pertinent to chemical spills. Dispersion, dilution and potentially very small volumes spilt will result in localised impact areas. No significant socioeconomic impacts are foreseen for fisheries tourism, oil and gas or shipping.

13.2.4 Mitigation

The following procedures will reduce the likelihood of chemical spills to the environment:

- A reduction in bunkering operations as far as practicable.
- CNRI routinely swap out perishable equipment such as hoses to ensure their integrity.
- Prior to transfer visual checks are undertaken by trained personnel in communication with the standby vessel.
- Observed leaks are reported and dealt with immediately by competent personnel and reported to the appropriate authorities.

Preventative measures and response strategies for chemical spills are aligned with those set out in the Murchison OPEP for hydrocarbon events (Table 13.4). The Murchison OPEP will be updated to reflect the change in operations and activities associated with decommissioning.

The impacts of all the chemicals that may be used or discharged offshore during decommissioning will be assessed and reported to DECC in a relevant PON15. Chemicals left in pipelines or umbilicals will be flushed and returned to the platform for disposal under appropriate permits.

All operations and mitigation will align with CNRI's infield procedures. Spills will be reported immediately utilising SHE-PRO-339 Reporting UKCS Chemical or Liquid Hydrocarbon Spills and Discharges.

13.2.5 Residual, Cumulative and Transboundary Impacts

The majority of chemical spills will likely pose little threat to the environment owing to a combination of rapid dispersion and dilution of the chemicals and the depth and distance from shore of the Murchison Field. The potentially low volumes that could be spilled are unlikely to pose any noticeable risk to residual, cumulative or transboundary impacts.

13.2.6 Conclusions

The conclusions from an impact assessment for an accidental chemical release include:

- Worst case scenario for chemical spills result from technical failure.
- Chemical spills will disperse and dilute quickly, with only localised effects to planktonic communities.
- The probability of a chemical spill occurring is low and does not significantly add to the overall spill risk in the area.
- The Murchison OPEP response will ensure that all chemical spills are dealt with efficiently.

13.3 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. In addition, the loss of larger objects may lead to the displacement of contaminated sediments such as cuttings piles. Dropped objects can vary in size from tools to large sections of topsides infrastructure or the loss of a vessel.

A debris survey report has been undertaken to assess the current status of seabed debris around the Murchison Facilities. During this survey low levels of debris were observed; the main debris was found to be minor metallic/scaffolding debris (ISS, 2010).

13.3.1 Potential Sources of Impact

The likely worst case scenario which imposes the greatest environmental and socioeconomic impact for a dropped object, would be the loss of a large section of jacket from the removal phase of the project or the sinking of a vessel during operations. As a result of an accident, a section of the upper jacket could fall to the seabed during the latter stages of the cutting operations, or while being transferred to a vessel. While it is most likely that the jacket section would become entangled on the remaining footings infrastructure, it is possible that the section would fall on or close to the drill cuttings pile and result in the re-suspension of cuttings or release of contaminants.

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, the amount of cuttings material disturbed 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 the historic discharge of cuttings at Murchison and the presence of a cuttings pile. However, if a large volume of cuttings material were re-suspended more or less instantaneously, effects may be experienced in the marine environment outside of the existing perturbation zone.

13.3.2 Impacts on Sensitive Receptors

Biological Receptors

In the event of a dropped object, the dominant receptor is the infaunal and epibenthic community in the drop zone. Comprehensive surveys have provided a detailed description of the resident benthic community below the Murchison facilities. Recent surveys have also allowed a comparison of community composition with historical surveys undertaken during the operational life of the field. For a summary of the benthic community and surveys undertaken see Section 5. Whilst the impact of a dropped object on the immediate drop zone may be significant, the effect is likely to be localised. The benthic community beyond 500 m from the Murchison Facility is indicative of, and comparable in diversity and composition with surrounding areas of the North Sea (Section 5). Therefore the impact of a dropped object should have no significant impact on the wider community. No other biological receptors will be impacted by a dropped object.

Socioeconomic Receptors

Any dropped objects will be recovered during decommissioning operations and an independent seabed clearance survey conducted once decommissioning operations have been completed to verify that a clean seabed has been left (excluding infrastructure that is expected to remain in place e.g. jacket footings).

No impacts relating to other socioeconomic receptors have been identified from dropped objects.

13.3.3 Mitigation

Where practicable all efforts will be made by CNRI to minimise the number of dropped objects. During decommissioning operations items will be secured to prevent loss wherever practicable.

Following completion of the decommissioning operations, surveys will be undertaken to assess the presence and potential recoverability of any lost objects from the Murchison Facilities wherever practicable. The recovery of such debris will be undertaken to minimise the impact on the environment and to minimise the risk to other users of the sea wherever possible.

13.3.4 Residual, Cumulative and Transboundary Impacts

These operations will be limited in duration and will only cause disturbance to a very localised area of seabed and the associated water column. They will not have any residual effects and will not contribute to cumulative or transboundary impacts.

13.3.5 Conclusions

The conclusions from an impact assessment for a dropped object include:

- Worst case scenario would be the loss of a major portion of the jacket during lifting operations.
- Dropped objects represent a significant snagging risk to fishing activities.
- Post decommissioning surveys will provide locations of dropped objects and assist in their removal where practicable.

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14.0 ENVIRONMENTAL MANAGEMENT

This section introduces relevant CNRI corporate policies and details the means by which CNRI will manage the environmental aspects of the Murchison decommissioning. This section catalogues the commitments made in support of the decommissioning proposals and provides a delivery mechanism for these commitments.

14.1 CNRI SHE Policy

CNRI takes all reasonable precautions to achieve the goal of harm-free operations. The SHE Policy (Figure 14.1) is CNRI's public commitment to conducting business in a manner that protects the health and safety of people and preserves the integrity of the environment within which they operate.

14.2 The CNRI Management System

CNRI's Safety, Health and Environmental Management System (SHEMS) is the means by which CNRI will:

- comply with SHE legislation and industry standards;
- manage SHE risks in the business; and
- deliver continuous improvement in SHE performance.

The scope of the CNRI SHEMS is offshore oil and gas exploration and development activities and associated onshore support. The system structure conforms to the broad principles of the Health and Safety Executive (HSE) publication Successful Health and Safety Management HS(G)65 and meets the requirements of general and offshore installation-related regulations.

In the North Sea, all of CNRI's directly managed platforms - Murchison, Ninian Central, Ninian Northern, Ninian Southern and Tiffany - are certified to ISO 14001:2004.

14.2.1 The CNRI Management System Structure

The SHEMS implemented on CNRI's offshore installations and within the onshore support organisation can be represented as a pyramid (Figure 14.2).

The CNRI SHEMS will be updated to encompass decommissioning activities, with the PLANC register and WMS for decommissioning forming part of the EMS.

CNR International

SAFETY, HEALTH AND ENVIRONMENTAL POLICY STATEMENT

CNR International (CNRI) is committed to achieving excellence in occupational and process safety, health, and environmental performance across our operations through continuous improvement. We will take all reasonable precautions to prevent harm to people and the environment, and to minimise risk on our facilities. We will work with our employees and contractors to ensure that our facilities are well designed, safely operated and properly maintained throughout their lifecycle.

In delivering excellence and in pursuit of harm-free operations, **we will always:**

- Comply with all relevant safety, health and environmental (SHE) legislation and regulatory requirements and, where these are absent, apply responsible company SHE standards
- Provide strong leadership to the identification, assessment and management of SHE risks at all levels of the organisation and promote a participative SHE culture that is open, fair and just
- Manage SHE risks as part of our everyday business and ensure effective controls are in place for third parties supporting our operations
- Set and monitor realistic but challenging SHE objectives and targets
- Ensure that everyone working for and on behalf of CNRI is aware of the SHE risks involved in their work, understands and fulfils their SHE roles and responsibilities, and is competent to carry them out
- Expect people to take personal responsibility for the potential SHE effects of their actions
- Monitor, audit and review our SHE performance and seek continuous improvement
- Talk to people, listen to their SHE issues or concerns and respond appropriately, and consult people on changes that affect their SHE risks significantly
- Provide the right resources to execute our business in line with our SHE policy
- Manage changes to our operations to ensure that SHE risks remain as low as reasonably practicable
- Ensure that effective emergency response measures are in place, and are well maintained
- Investigate incidents and near misses effectively to prevent their recurrence, and ensure that any lessons learned, including those from the experiences of others, are properly communicated to all parts of the organisation
- Ensure that our SHE Management System, including this policy, is well maintained and remains effective through regular review

James Edens
Vice President & Managing Director, CNR International (U.K.) Limited

SHE-POL-001 Rev 05

April 2012

Figure 14.1: CNRI SHE Policy Statement

Figure 14.2: The CNRI SHEMS

14.3 CNRI Management Standards

CNRI has ten Management Standards directly supporting the SHE Policy. These describe expectations and requirements for performance in relation to key aspects of SHE management. The Management Standards allow for some flexibility in terms of SHEMS implementation, to permit different parts of the company to meet these expectations in different ways, depending on particular legal and other business drivers.

The ten Management Standards are:

- Leadership and Commitment.
- Performance Management.
- Managing SHE Risks.
- Competence and Personal Development.
- Communication and Involvement.
- Working with Third Parties.
- Change Management.
- Information and Documentation.
- Emergency Preparedness.
- Incident Reporting, Investigation and Analysis.

14.4 CNRI General and Installation-Specific Procedures

CNRI General Procedures support specific Management Standards and, where documented procedures are needed, they describe the arrangements in place to meet the appropriate standard, for example incident reporting or oil spill response. These procedures are intended to provide consistency across the organisation; they are applicable to any operation and are generally not specific to any one location or installation.

Installation- and location-specific procedures are particular to an operation or activity. They define the arrangements that CNRI have determined are needed to conform to General Procedures and thus meet the spirit and intent of the Management Standards.

14.5 Register of Commitments

A Register of Commitments has been developed to address each aspect of the Murchison Decommissioning Project (Table 14.1) and provides a summary of key management and mitigation measures identified during the EIA process. This register will form part of the Decommissioning Environmental Management Plan (Section 14.6) and will be integrated into the relevant project phases. Mitigation measures identified and commitments made will also be embedded into the following documents to ensure appropriate execution and management:

- detailed engineering specifications;
- contracts; and
- execution plans.

Table 14.1: Register of Commitments

Issue	Commitment	Project Phase	
		Design	Execution
Environmental responsibilities	Key environmental responsibilities, duties, communication, reporting and interface management arrangements of CNRI and the main contractors involved in the decommissioning activities will be agreed, documented and communicated at the appropriate stages of the project.	✓	✓
EMS	The contractors will have in place EMSs that align with the CNRI EMS.	✓	✓
	Vessels will be subject to audits as part of CNRI selection and pre-mobilisation and management system requirements.	✓	✓
Delivery of commitments	The commitments made within this ES will be incorporated into operational work programmes, plans and procedures. Programmes will be tracked to ensure that commitments and mitigation measures are implemented throughout the project.	✓	✓
Atmospheric emissions	Vessels will be audited as part of selection and pre-mobilisation.		✓
	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.	✓	

Table 14.1 (continued): Register of Commitments

Issue	Commitment	Project Phase	
		Design	Execution
Underwater noise	During decommissioning operations, regular observations for marine mammals in the area will be made and the cetacean observation logs made available to JNCC.		✓
	Offshore vessels will avoid concentrations of marine mammals and maintain a steady course and speed when possible.		✓
	The operation of well-maintained equipment during the decommissioning activities will ensure that the noise of operating machinery is kept as low as possible during the decommissioning operations.		✓
	The number of vessels travelling to, or standing by, Murchison will be kept to the minimum.		✓
Seabed disturbance	Cutting and lifting operations of subsea equipment will be controlled and any impact on seabed sediment will be minimised.		✓
	Rock-placement will be minimised to reduce seabed footprint and profiled to minimise the risk of snagging to fishing gear.	✓	✓
	Drill cutting pile disturbance will be minimised.		
	Post-installation surveys of the seabed will be carried out to identify significant anomalies and dropped objects.		✓
Socioeconomic	Other sea users will be alerted to the decommissioning activities by consultation.	✓	
	Kingfisher alerts, notices to mariners, use of guard vessels, and fisheries liaison officers will be issued, where appropriate.		✓
	The number of vessels travelling to, or standing by, Murchison will be kept to the minimum.		✓
Waste	Waste management plan will be developed	✓	✓
	Regular internal and third party audits will be carried out to assess the effectiveness of and conformity to, waste management procedures.		✓
	Staff will undergo appropriate training and will be notified of the separation and disposal requirements for each category of waste.		✓
Discharges to Sea	The management of ballast water will meet International Maritime Organization (IMO) guidelines.	✓	✓
	Chemical selection will be governed by the CNRI chemical selection philosophy and in accordance with Offshore Chemicals Regulations 2002 (as amended 2011).		
	Where required, chemicals, fuel and lubrication oil storage areas will be bunded in order to contain drips and spills, and minimise the risk of overboard discharge.		✓
Accidental Spills	All efforts will be made to minimise dropped objects lost overboard.		✓
	Surveys will be undertaken to assess the presence and potential recoverability of any lost objects from the Murchison Facilities wherever practicable.		✓
	Where possible, dropped objects will be recovered. Should dropped objects remain on the seabed, H.M Coastguard will be informed immediately of any potential hazard to shipping, and a navigation warning issued.		✓

14.6 Decommissioning Environmental Management Plan

The Decommissioning Environmental Management Plan (DEMP) summarises the mitigation measures and commitments made within this ES and translates these into specific actions with identified owners. An example DEMP is illustrated within Table 14.2 and this will be developed as the project evolves including, for example, to accommodate terms and conditions specified in project approval or stakeholder concerns.

14.6.1 Roles and Responsibilities

The roles and responsibilities of CNRI, contractors and subcontractors will be clearly identified and the interrelationship between these entities defined.

The organisational chart for the current project phase is focussed on the roles required to manage the planning phase including the Decommissioning Programme and the EIA process. As contracts are awarded over the next two years, the organogram will evolve to incorporate the different project phases, for example, EDC, Removals Contract, etc., which will be managed accordingly.

14.6.2 Contractor Interface

Contractor interface documents will be developed to manage environmental commitments during decommissioning. The interface document will detail the management organisation, the communication and reporting lines and the division of responsibilities during operational and emergency situations. Figure 14.3 shows how the company management systems will interface.

14.7 Staff Training and Awareness

Training and competency is managed through individual contracts and CNRI stipulating minimum standards of training and competency that are required for personnel to undertake work on CNRI’s behalf. These comprise both industry-standard training/awareness and technical Standards which are usually to OPITO level. Compliance with this is demonstrated at quarterly performance reviews. Contractors are also independently audited regularly with training and competency forming a key part of these audits. In addition, contractors working offshore have a platform-specific induction which includes specific Health, Safety and Environmental content.

14.8 Environmental Monitoring

Decommissioning operations will be conducted under the relevant licences and permits applied for by CNRI. Monitoring and reporting to the regulator and internally will be conducted in accordance with relevant legislation and these licences. For example, discharges to sea from chemicals and residual hydrocarbons will be permitted appropriately and any accidental discharges to sea will be reported and investigated through CNRI’s incident investigation process.

CNRI have arrangements in place for monitoring SHE performance and compliance with legislation, company policy, standards and procedures. Two approaches to monitoring are applied: active (providing feedback on performance) and reactive (providing information on incidents, accidents and near misses). Appropriate performance measures will be established for monitoring progress against achievement of defined goals and targets and appropriate arrangements shall be in place to ensure the effective collation and reporting of this performance data.

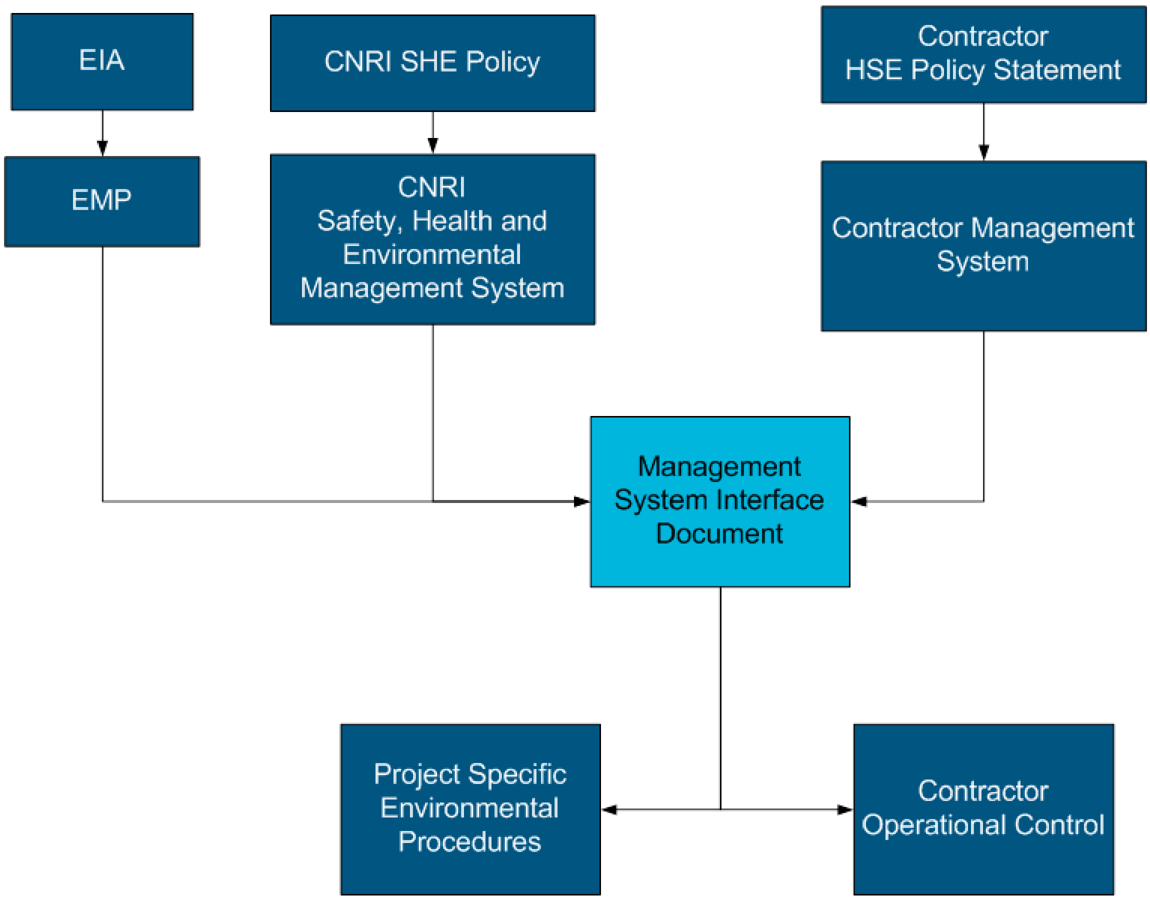

Figure 14.3: Contractor Interface Management

14.9 Performance Monitoring (Inspection, Audit and Corrective Actions)

Monitoring will be performed by internal and external parties. The scope and frequency of internal monitoring depends on an assessment of risks performed by line managers, process owners and corporate staff functions. Internal monitoring consists of three main categories: follow-up, verification, and internal audit.

Auditing associated with decommissioning will be identified and scheduled in the CNRI SHEMS Audit Programme prior to and during ongoing decommissioning operations.

Table 14.2: Example of a typical DEMP

Issue	Source of Impact	Mitigation	Action	Responsibility	Timing	Verification
Odour generation from decay of organic matter	Onshore cleaning marine growth from jacket, conductors using high pressure jet cleaners	• Assess use of chemicals to neutralise odour • Ensure that cleaning is undertaken in as short a time as possible	• Audit of disposal yards to assess options • Ensure that contractor scope of work addresses specific environmental issues	Environmental Advisor	Before contract award and throughout decommissioning	• Audit of disposal yards during decommissioning • Regular interface communication and meetings with contractor • Performance reports to be provided by contractor

15.0 CONCLUSIONS

An EIA is an important management tool used by CNRI to ensure that environmental considerations are incorporated into decommissioning planning and decision making. This ES presents the findings of an EIA for the recommended options for the decommissioning of the Murchison Facilities and provides sufficient information to enable an evaluation to be made of the environmental consequences of the proposed activities.

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

There are no known Annex I habitats in the Murchison Facilities area. Although *Lophelia pertusa* has colonised the Murchison Platform, it would not have occurred without the presence of the platform and therefore the location does not constitute an Annex I habitat (JNCC, Section 5).

Harbour porpoise were the only Annex II species of the Habitats Directive recorded within and around the Murchison Facilities. They exhibit very high abundance in February and July, and low numbers throughout the summer months (May, June, August and September) (DECC, 2009b; SMRU, 2001).

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

- Effects of energy use and atmospheric emissions (Section 8).
- Effects of underwater noise generated during decommissioning activities (Section 9).
- Effects of seabed disturbance during decommissioning operations - vessel anchoring, rock-placement, etc. (Section 10).
- Habitat change as a result of pipeline rock-placement (Section 10).
- Effects of drill cuttings disturbance (Section 10).
- Effects associated with Murchison cuttings pile management (Section 10).
- Physical presence of vessels causing potential interference with other users of the sea (Section 11).
- Socioeconomic impact to fishermen from the derogated footings and pipelines (Section 11).
- Cleaning of marine growth from Murchison jacket (Section 12 and Appendix B).
- Landfill disposal and associated impacts (Section 12).
- Non-routine events – spillage of hydrocarbons and other fluids (Section 13).

Mitigation to avoid and reduce the above environmental concerns is in line with industry best practice. CNRI has an established EMS, which will ensure that proposed mitigation measures are implemented (Section 14).

Overall, the ES has evaluated the environmental risk reduction measures to be taken by CNRI and concludes that CNRI have, or intend to, put in place sufficient safeguards to mitigate environmental risk and to monitor the implementation of these safeguards.

Therefore, it is the conclusion of this Environmental Statement that the recommended options to decommission the Murchison Facilities can be completed without causing significant impact to the environment.

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Appendix A
Summary of Environmental Legislation

This appendix presents a summary of the key regulatory drivers applicable to the Murchison 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 n 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 and2009/31/EC.	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 1: 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. Annex 2: EIA is discretionary with the national authorities decide whether an EIA is needed. This is done by the "screening procedure", which determines the effects of projects on the basis of thresholds/criteria or a case by case examination.
	EC Directive 2012/92/EU on the assessment of the effects of certain public and private projects on the environment	The EC Directive 2012/92/EU revokes the 85/337/EEC and the 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 1 projects.
	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 PON15 (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

Table A.3 (continued): Environmental Impact Assessment

Regulatory Body	Legislation	Summary of Requirements
DECC	Environmental Approval for Revised Production Consents under PPD (Revised)	The EC Directive 2012/92/EU on the assessment of the effects of certain public and private projects on the environment forced an amendment of the EIA regulations. An ES may now also be required for a modification to a project or revision to production consent, unless the modification or revision decreases production, has no change on production levels or increases production only by a small amount. Prior to applying to EDU (Energy Development Unit) to request a consent revision or renewal that involves an increase in the production level, the applicant should assess the proposed increase against the EIA thresholds (*), as follows: If the average requested annual rate of production represents an increase of greater than 500 tonnes of oil per day or 500,000 cubic metres of gas per day, an EIA Direction or ES will be required If the increase in production does not exceed the base year i.e. the first year of the consent in subsequent years then an EIA Direction or ES will not be required. If the increase is for an increase in the base year production then an EIA Direction or ES will be required. If the increase in subsequent years exceeds production in the base year, an EIA Direction or ES will be required Revised guidance relating to Environmental Submissions was issued by DECC on the 21st of July 2011 highlighted changes that have been made to relevant regulations following the Gulf of Mexico incident. The guidance highlighted the fact that EIAs must include a detailed assessment of the potential environmental impact of a hydrocarbon release, broadly based on OPEP (Oil Pollution Emergency Plan) requirements but including significant additional information to the mitigation measures in place to prevent and the potential environmental impacts of the release.
	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 require ships (including platforms and drilling rigs) to be issued with an International Air Pollution Certificate following survey. This annex set limits on sulphur oxide and nitrogen oxide emissions from ship exhausts as well as particulate matter and prohibit 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	Petroleum Act 1998 The Petroleum (Current Model Clauses) Order 1999	The objective of this Act is to conserve gas, as a finite energy resource, by avoiding unnecessary wastage during the production of hydrocarbons in the UKCS. The actual Model Clause may vary depending on when the Block Licence was granted, but in recent licences flaring is covered by Paragraph 3 of Model Clause 21, and this states that the Licensee shall not flare any gas from the licensed area or use gas for gas lift except with written consent. If intending to flare gas during the operational phase of the field, flare consent will need to be obtained.
	The Energy Act 1976	This Act is mostly used for issue of vent consents, although it also covers some flaring which has not been permitted under licence model clauses. The VOC emissions from offshore loading are covered by the Vent Consent requirements under the Energy Act 1976.
	The National Emission Ceilings Regulations 2002	There regulations transpose 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 and 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)	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 (continued): Atmospheric Emissions

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 "best available techniques" (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.
	The Fluorinated Greenhouse Gases Regulations 2009	The objective of these Regulations is to reduce the emissions of fluorinated gases including hydrofluorocarbons, perfluorocarbons and sulphur hexafluoride as covered by the Kyoto Protocol. These gases have been developed to replace ozone depleting substances such as CFCs 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 Environmental Protection (Controls on Ozone Depleting Substances) Regulations 2011	The 2011 regulations revoke and replace the previous regulations. These Regulations make provision in the UK for EC Regulation 1005/2009 which controls the production, impact, export, placing on the market, recovery, recycling, reclamation and destruction of substances that deplete the ozone layer.

Table A.5 (continued): Atmospheric Emissions

Regulatory Body	Legislation	Summary of Requirements
DECC	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 2005 (as amended 2007) 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.
	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 2011 The Conservation of Habitats and Species (Amendment) Regulations 2011.
	The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 as amended 2007	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) (Scottish Inshore and Offshore Regions) Amendment Order 2012	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.
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	CITES is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

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.
	OSPAR Recommendation 2010/18 on the prevention of significant acute oil pollution from offshore drilling activities	This recommendation came into force in September 2010 and establishes a process for assessing the relevance of the results of the US and EC reviews of the Macondo well incident with a view to taking additional action by the OSPAR Commission if needed and within the scope of the Convention. Under the recommendation, contracting parties are required to: As a precaution continue or, as a matter of urgency, start reviewing existing frameworks, including the permitting of drilling activities in extreme conditions; and continue to evaluate this on a case by case basis and prior to permitting; Take extra care to apply all relevant learning from the Deepwater Horizon accident; Report on this ongoing activity to OSPAR; and Based on the reviews undertaken, contracting parties should individually and jointly, if needed, take further action within the scope of the OSPAR Convention.
	Merchant Shipping Act 1995	The Merchant Shipping Act 1995 implements in the UK the 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 (Oil Pollution Preparedness, Response and Co-operation Convention) Regulations 1998 introduce into UK law the oil spill planning requirements and legal oil spill reporting requirements of the OPRC Convention.

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 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 EC has published a communication (the Communication) on "facing the challenge of the safety of offshore oil and gas activities". The European Commission is set to review the liability regime applicable to offshore petroleum activities and is: proposing amendments to the Environmental Liability Directive (2004/35/EC, as amended by Directive 2006/21/EC) so that it covers environmental damage to all marine waters (as defined in the Marine Strategy Framework Directive 2008/56/EC); re-considering introducing a mandatory requirement for operators to provide financial security in the event that a major accident occurs; and considering, in a guidance document interpreting existing legislation, the applicability of the Waste Framework Directive (2008/98/EC) to oil spills
	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 CHARM model. Applications for permits are made via the submission of the relevant PON15 (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 oil based fluids (OBF) (includes OBF and 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/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 15ppm. 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 (continued): Chemicals, drainage and oily discharges

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 1 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 FSU) 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.
	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 (continued): Waste handling and disposal

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. These regulations 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 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.
	The Waste Electrical and Electronic Equipment Regulations 2006 (as amended 2010)	These Regulations transpose the requirements of the Waste Electrical and Electronic Equipment Directive (WEEE Directive 2002/96/EC) which came into force in January 2007. The Regulations define new responsibilities for users and producers of Electrical and Electronic Equipment depending on whether the equipment was purchased before or after 13/08/05. The 2010 Amendments modify various definitions and realign dates.

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 (England and Wales) Regulations 2010 in England and Wales 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 keeping, storage and disposal of radioactive waste requires authorisation. The Radioactive Substances Act 1993 has been superseded by the Environmental Permitting (England and Wales) Regulations 2010 in England and Wales but 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.

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.
	UK Marine & Coastal Access Act 2009	The UK Marine & Coastal Access Act has gained Crown Assent, thus becoming an Act of Parliament and entering UK law. The Act provides executive devolution to Scottish Ministers of the new marine planning and conservation powers in the offshore region (12-200 nautical miles), coinciding with the existing executive devolution of marine licensing. The Scottish Bill will legislate for marine planning, licensing and conservation activities in the inshore region.

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 nm from the nearest land and at least 200 metres deep.

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.

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, which will provide an opportunity to update the Coast Protection Act regime currently being implemented on behalf of the Department of Transport. The consultation closing date was the 30th November 2012.
	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 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 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.

Appendix B
Summary of the Environmental Impacts Identification Workshop Results

Tables B.1 to B.9 details the findings of the Environmental Impacts Identification workshop (BMT Cordah, 2012a). Impacts classified as "moderate" or greater significance are assessed in more detail in Sections 8 to 13. Tables B.1 to B.9 also identifies the proposed control and mitigation measures to reduce and / or avoid each identified potential effect associated with the proposed decommissioning of the Murchison Facilities.

Table B.1: Use of vessels – all decommissioning activities

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
The use of vessels, and offshore transportation, during all types of offshore operations									
1) Physical presence of vessels outside 500 m zone	Obstruction potential loss of access to fishing areas and commercial shipping routes.	Commercial fishing, shipping, stakeholders .	2	2	L	Commercial Fisheries – Socioeconomic Impact Study.	Up-to-date shipping route data within vicinity of Murchison Facilities.	Notice to Mariners, Kingfisher, regular updates/e-mails on vessel moves. Industry standard. Commissioned study to determine shipping routes within the vicinity of Murchison Facilities.	Environmental Management Plan.
2) Vessel movement and station keeping	Generation of underwater noise causing potential disturbance to marine life.	Marine mammals, fish, cumulative and transboundary.	3	3	M	Underwater noise impact assessment.	-	Running machinery efficiently, maintaining vessels, minimising vessel use through vessel management plan.	Environmental Management Plan.
3) Anchoring on seabed	Physical disturbance to seabed and suspension of sediment into the water column.	Sediments, benthos, water column, fish, stakeholders.	5	1	L	Pre-decommissioning environmental baseline survey report Methods statements from removal contractors.	-	Site survey data will be used to pre-determine an appropriate anchor plan with the minimum number of anchor moves.	Environmental Management Plan.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
4) Anchoring on contaminated sediments within 500 m of the platform but not on the drill cuttings pile	Physical disturbance of contaminated sediments potentially releasing toxic contaminants into the water column and seabed, which may impact pelagic and demersal species.	Sediments, benthos, water column, fish, plankton, stakeholders.	3	1	L	Pre-decommissioning environmental baseline survey report Methods statements from removal contractors.	-	Site survey data will be used to pre-determine an appropriate anchor plan, which will avoid the drill cuttings pile and utilise the minimum number of anchor moves.	Environmental Management Plan.
5) Vessel discharges e.g. sewage	Release of contaminants leading to deterioration in seawater quality and localised increase in BOD around the discharge point.	Water column, plankton, fish.	5	1	L	Removal contractor's schedule of vessel operations.	-	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.	Environmental Management Plan.
6) Vessel discharges e.g. ballast water inshore	Deterioration in seawater quality around the discharge point, and risk of introducing alien invasive species.	Water column, plankton, benthos, fish, stakeholders.	5	1	L	Removal contractor's schedule of vessel operations.	-	IMO 2004 International Convention for the Control and Management of Ships' Ballast Water and Sediments, is in the process of being ratified, if ratified vessels will be audited to ensure compliance.	Environmental Management Plan.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
7) Power generation for vessel operation	Energy use leading to atmospheric emissions of CO_2 and VOC which may contribute to climate change; emissions of NO_x and SO_x which may contribute to acid rain.	Use of resources, atmosphere, cumulative, transboundary, stakeholders.	5	1	L	Energy and Emissions report Removal contractor's schedule of vessel operations.	-	Planning vessel schedules to optimise movement and minimise fuel consumption and atmospheric emissions. Comment: Total CO_2 emissions generated by Murchison during normal operations in 2011 was 204,574 tonnes; power use for vessel use during decommissioning operations will be significantly lower.	Environmental Management Plan.
8) Vessel movement inshore	Noise in air from vessels close to shore / in harbour.	Communities.	1	1	L	Removal contractors schedule of vessel operations.	The onshore decommissioning yard is unknown at this stage of the project. The potential impacts of noise in air have not been assessed.	An existing onshore yard will be selected which is already regularly used by vessels, therefore unlikely to result in a significant change to current noise levels. Planning vessel schedules to optimise movement and minimise noise generation.	Environmental Management Plan.
Emergency Events relating to the use of vessels									
9) Vessel collision with another vessel leading to vessel sinking.	Physical presence of wreck leading to snagging risk, disturbance to seabed, litter on the seabed.	Sediment, water column, benthos, plankton, fish, commercial fishing, shipping, other users, stakeholder, transboundary	1	3	L	Removal contractor's schedule of vessel operations.	Shipping routes in the vicinity of Murchison Facilities.	Planning vessel schedules, Notice to Mariners, Kingfisher, regular updates/e-mails on vessel moves. Industry standard.	Commission a shipping and collision risk assessment. Environmental Management Plan.

CNR International

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
10) Major oil spill as a result of vessel collision with another vessel (>100 t fuel oil)	Major release of fuel oil into the marine environment.	Sediment, water column, atmosphere, benthos, plankton, fish marine mammals, birds, commercial fishing, shipping, other users, coastal conservation sites, stakeholder, cumulative, transboundary.	1	5	L	Removal contractor's schedule of vessel operations. Pre-decommissioning environmental baseline survey report. ES Environmental baseline description. Murchison OPEP and vessel SOPEP.	Current oil spill modelling.	Standard procedures including: CNRI Infield Safety Procedures. SHE-PRO-339 Reporting UKCS Chemical or Liquid Hydrocarbon Spills and Discharges. SHE-PRO-903 Principal Oil Pollution Emergency Plan. OPS-PRO-1009 Murchison Oil Pollution Emergency Plan.	Audit vessel contractors Review current OPEP and industry best practice. Planning vessel schedules Commission a shipping and collision risk assessment.
11) Accidental fuel spills during decommissioning operations e.g. fuel bunkering	Release of diesel fuel or aviation fuel to the marine environment.	Water column, atmosphere, plankton, fish, birds, commercial fishing transboundary.	3	3	M	Removal contractor's schedule of vessel operations. Pre-decommissioning environmental baseline survey report. ES Environmental baseline description. Murchison OPEP and vessel SOPEP.	Current oil spill modelling.	Standard procedures: SHE-PRO-339 Reporting UKCS Chemical or Liquid Hydrocarbon Spills and Discharges. SHE-PRO-903 Principal Oil Pollution Emergency Plan. OPS-PRO-1009 Murchison Oil Pollution Emergency Plan. OS-PRO-154 4 Management and Use of Flexible Hoses Including Bulk Transfer Procedure.	Audit vessel contractors. Review current OPEP and industry best practice. Planning vessel schedules. Commission a shipping and collision risk assessment.

Table B.2: Post cessation of production activities: plugging and abandonment of wells, conductor recovery, topsides engineering down, cleaning and preparation.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Potential impacts associated with post cessation of production activities: plugging & abandonment of wells, conductor recovery, engineering down and cleaning									
1) Well P&A Tubing recovery	Release of residual contaminated fluids.	Sediments, water column, benthos, fish, transboundary.	1	1	L	EDC Scope and interfaces.	-	All new chemicals will be risk-assessed and covered by the relevant discharge permit under the Offshore Chemical Regulations 2002. Chemicals within the tubing will be covered within the relevant discharge permit at the time of decommissioning.	Environmental Management Plan.
									-
2) Well P&A cutting conductor	Generation of underwater noise causing potential disturbance to marine life.	Fish, marine mammals, cumulative, transboundary.	3	2	L	ES Environmental baseline description. Underwater noise impact assessment.	Absence of published or industry data to quantify the underwater noise generated by specific cutting equipment, assumptions have been made based on the known source levels of diver operated tools (BMT Cordah, 2011c - Noise).	Planned efficient cutting regime to achieve as few cuts as possible. Evidence suggest that noise generated will be low frequency (200 Hz), potentially resulting in a zone of radius 4 km within which marine mammals may experience disturbance. The cutting operations are expected to be short in duration, lasting a few hours each, over a period of days to weeks.	Environmental Management Plan.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
3) Well P&A conductor recovery to surface.	Loss of marine growth and release of organic matter as conductors pulled through guides.	Sediments, water column, benthos, fish, stakeholders.	1	1	L	ES Environmental baseline description. Murchison marine growth assessment 2010.	-	-	-
4) EDC	Planned release of residual fluids from flushing and cleaning of topside systems, pipework & tanks, resulting in release of contaminants (e.g. hydrocarbons, cleaning solutions).	Water column, fish, plankton, transboundary.	1	1	L	EDC Scope and interfaces.	-	All new chemicals will be risk-assessed and covered by the relevant discharge permit under the Offshore Chemical Regulations 2002. Chemicals within the topsides system will be covered within the relevant discharge permit at the time of decommissioning.	Environmental Management Plan.
5) Topside preparation for removal using hot cutting, welding etc	Generation of material and dust to the atmosphere and onto the sea surface/water column.	Water column, plankton, fish, atmosphere.	1	1	L	ES Environmental baseline description. Removal contractor's schedule of vessel operations. Murchison Platform materials inventory.	Hazardous Materials Study.	Workpacks and procedures for topsides preparatory works. Containment procedures.	Environmental Management Plan.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
6) Power generation for running topsides during well P&A activities through continued operation of the two main power generators and temporary generators.	Energy use leading to atmospheric emissions of CO_2 and VOC which may contribute to climate change; emissions of NO_x and SO_x which may contribute to acid rain.	Use of resources, atmosphere, cumulative, transboundary, stakeholders.	5	1	L	Well P&A schedule Energy and Emissions Report Technical Note: Murchison well P&A and topsides decommissioning activities post CoP.	-	Emissions will be minimised through the use of well-maintained equipment.	Environmental Management Plan.
Emergency and non-routine events									
7) Loss of minor/small items e.g. scaffold within 500 m of the platform.	Physical disturbance to seabed and suspension of sediment into the water column.	Sediment, benthos, fish.	3	1	L	Pre-decommissioning environmental baseline survey report ES Environmental baseline description.	-	Post-decommissioning debris clearance operations.	Environmental Management Plan.
8) Conductor dropped during recovery within 500 m of the platform.	Physical disturbance to seabed and suspension of sediment into the water column.	Sediment, benthos, fish, fishing.	3	1	L	Pre-decommissioning environmental baseline survey report. ES Environmental baseline description.	-	Accurate accounting for all casing sections and major items of equipment. 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.	-

Table B.3: Topside decommissioning

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Potential impacts associated with topsides decommissioning: both reverse installation & piece small removal									
1) Power generation for the manufacture of temporary steelwork.	Energy use leading to atmospheric emissions. (Refer to Table B.1).	Use of resources, atmosphere, cumulative, transboundary, stakeholders.	5	1	L	Energy and emissions report. Methods statements from removal contractors.	-	Emissions will be minimised through the use of well-maintained equipment.	Environmental Management Plan.
2) Power generation for vessel operations.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
3) Vessel discharges e.g. sewage.	Release of contaminants leading to deterioration in seawater quality and localised increase in BOD around the discharge point.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
4) Power generation for dismantling structures inshore.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
5) Power generation for onshore transportation of recovered material to recycling site or landfill facility.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			

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Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Option 1: Reverse Installation (Duration: 150 or 280 days depending on sub-option)									
6) Power generation for module separation and cutting (plasma, flame or cold cutting).	Energy use leading to atmospheric emissions.	Use of resources, atmosphere, cumulative, transboundary, stakeholders	5	1	L	Energy and emissions report	-	Planned efficient cutting regime to achieve as few cuts as possible. Emissions will be minimised through the use of well-maintained equipment.	Environmental Management Plan.
7) Module separation and cutting (plasma, flame or cold cutting).	Release of contaminants and dust, residual hydrocarbons, etc.	Water column, plankton, fish, atmosphere, noise - in air	1	1	L	ES Environmental baseline description Removal contractor's schedule of vessel operations Murchison Platform materials inventory	Hazardous Materials Study	Workpacks and procedures for topsides preparatory works, under which any hazardous materials will be identified and contained. Containment procedures.	Environmental Management Plan.
8) Power generation for heavy lift vessel at site, during transportation to shore and transfer of modules to cargo barge.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
9) Mooring of cargo barge to support HLV.	Physical disturbance to seabed and suspension of sediment into the water column.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
10) Power generation for dismantling structures inshore.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
11) Dismantling structures/ recovered material onshore.	Dust and noise in air generation.		3	2	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
Option 2: Piece small removal									
12) Offshore dismantling including hot/cold cutting, excavators or demolition robots.	Energy use leading to atmospheric emissions.	Use of resources, atmosphere, cumulative, transboundary, stakeholders.	5	1	L	Energy and emissions report Removal contractor's schedule of vessel operations.	-	Planned efficient cutting regime to achieve as few cuts as possible. Emissions will be minimised through the use of well-maintained equipment.	Environmental Management Plan.
13) Offshore dismantling including hot/cold cutting, excavators or demolition robots.	Release of contaminants such as paint chipping, dust, and residual hydrocarbons that may be toxic to marine life.	Atmosphere, water column, noise - in air.	3	2	L	ES Environmental baseline description Removal contractor's schedule of vessel operations Murchison Platform materials inventory.	Hazardous Materials Study.	Workpacks and procedures for topsides preparatory works, under which any hazardous materials will be identified and contained. Containment procedures.	Environmental Management Plan.
14) Presence of accommodation support vessel (anchors located 500-1000 m away from platform, for 55 days).	Physical disturbance to seabed and suspension of sediment into the water column.	Sediments, benthos, water column, fish.	5	1	L	Pre-decommissioning environmental baseline survey report.	-	Anchor plan will avoid cuttings pile and will utilise the minimum number of anchor moves. Anchoring would be subject to MCAA licence.	Environmental Management Plan.
15) Increased supply boat activity.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
16) Increased supply boat activity resulting in vessel discharges e.g. sewage.	Release of contaminants leading to deterioration in seawater quality and localised increase in BOD around the discharge point.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
17) Power generation for vessel operation for HLV lift of accommodation block and MSF activity.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
Emergency events relating to topsides decommissioning									
18) Module loss during lifting and transportation.	Physical disturbance to the seabed adjacent to the platform potentially resuspending contaminants sediments to the water column.	Sediments, water column, benthos, fish, transboundary, stakeholders.	3	2	L	Pre-decommissioning environmental baseline survey report ES Environmental baseline description.	Murchison drill cuttings pile human disturbance modelling.	Detail procedures for heavy lift operations. Module recovery.	-
19) Loss of minor items during module separation e.g. scaffold within 500 m of the platform.	Loss of metal debris / swarf resulting in physical disturbance to seabed	Sediments, benthos, fish.	3	1	L	Pre-decommissioning environmental baseline survey report ES Environmental baseline description.	-	Post-decommissioning debris clearance operations.	-

Table B.4: Jacket decommissioning

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Potential impacts from jacket decommissioning operations: full (-156 m depth) and partial (-113 m depth) removal, for conventional heavy lift, single lift and small crane vessel									
1) Power generation for manufacture of temporary steelwork.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.3 - Potential impacts associated with topsides decommissioning: both reverse installation & piece-small removal.			
2) Vessel discharges e.g. sewage.	Release of contaminants leading to deterioration in seawater quality & localised increase in BOD around the discharge point.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
3) Power generation for vessel operations.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
4) Power generation for dismantling structures inshore.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
5) Dismantling structures/ recovered material onshore.	Generation of dust and noise in air.		3	2	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
6) Power generation for onshore transportation of recovered material to recycling site or landfill facility.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table 9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
7) Offshore removal of marine growth from whole jacket using high pressure jet cleaner.	Release of organic matter at offshore site.	Sediments, water column, benthos, fish, transboundary, stakeholders.	2	2	L	ES Environmental baseline description Murchison marine growth assessment 2010. UKOOA JIP Marine Growth Management Report.	-	-	CNRI will define options for cleaning marine growth and assess the restrictions for disposal onshore in Environmental Management Plan.
10) Underwater cutting (techniques include DWC, AWJ, hydraulic shear).	Generation of underwater noise causing potential disturbance to marine life. [The use of explosives is not anticipated].	Marine mammals, fish, cumulative, transboundary.	3	2	L	ES Environmental baseline description Underwater noise impact assessment	Absence of published or industry data to quantify the underwater noise generated by specific cutting equipment, assumptions have been made based on the known source levels of diver operated tools (Cordah, 2011 - Noise).	Planned efficient cutting regime to achieve as few cuts as possible. Evidence suggest that noise generated will be low frequency (200 Hz), potentially resulting in a zone of radius 4 km within which marine mammals may experience disturbance. The cutting operations are expected to be short in duration, lasting a few hours each, over a period of days to weeks.	-
11) Power generation for underwater cutting (techniques include DWC, AWJ, hydraulic shear).	Energy use leading to atmospheric emissions.	Use of resources, Atmosphere, cumulative, transboundary.	5	1	L	Energy and emissions report Methods statements from removal contractors.	-	Planned efficient cutting regime to achieve as few cuts as possible. Emissions will be minimised through the use of well-maintained equipment.	Environmental Management Plan.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
12) Cut through diesel storage tanks in jacket legs during platform removal.	Release of residual diesel contamination to the marine environment.	Water column, plankton, fish	1	1	L	EDC Scope and interfaces Methods statements from removal contractors	-	-	Diesel storage tank cleaned to acceptable standards prior to cutting in accordance with relevant permit requirements.
Potential impacts associated with BTA jacket flotation and grounding at inshore fjord - partial removal (-113 m depth) (726 days demolition within fjord location)									
13) Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway.	Physical disturbance to the seabed sediment and organisms from placement of the jacket on the seabed at the inshore fjord location.	Sediments, water column, benthos, fish, plankton	5	2	M	Methods statements from removal contractors	Environmental baseline description including survey data within the inshore fjord location at Hille, Norway.	Comment: The seabed at Hille is very hard moraine (glacial deposit), and was used as grounding area for the Frigg Jacket DP2. The jacket was supported on piles only, and the piles penetrated seabed less than 1m. Rock-placement is not expected.	EIA would be required to cover the full environmental impacts associated with this option if selected.
14) Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway.	Potential introduction of marine invasive species from marine growth on the jacket to inshore fjord location.	Benthos, fish, plankton, stakeholders	2	3	L	Murchison Marine Growth Report	Environmental baseline description within the inshore fjord location at Hille, Norway.	Comment: The species of marine growth present on the Murchison jacket are typically found within the wider North Sea area. No rare or unusual species have been recorded.	Environmental Management Plan.
15) Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway.	Removal of some marine growth inshore to access areas for cutting may result in deterioration in seawater quality and localised increase in BOD around the discharge point and may impact local fish farms and benthic communities.	Commercial fishing, stakeholders	4	1	L	Murchison Marine Growth Report	Levels of fish farming within the inshore fjord location at Hille, Norway.	Comment: Marine growth would primarily be removed onshore, relatively small amounts removed inshore if necessary to access cut locations on the jacket. Many fish farms cause organic enrichment of bottom sediments from the vast discharge of organic matter from the net pens, this is likely to exceed the organic enrichment from marine growth on the jacket.	EIA would be required to cover the full environmental impacts associated with this option if selected.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
16) Cutting the partial jacket into sections at inshore site for transportation to shore – 113 m water depth, at Hille near Aker Stord, Norway.	Generation of underwater noise causing potential disturbance to marine life.	Marine mammals, fish, cumulative, transboundary.	3	3	M	Underwater noise impact assessment – assumption of noise cutting levels.	Environmental baseline description including survey data within the inshore fjord location at Hille, Norway.	Planned efficient cutting regime to achieve as few cuts as possible. Evidence suggest that noise generated will be low frequency (200 Hz), potentially resulting in a zone of radius 4 km within which marine mammals may experience disturbance. The cutting operations are expected to be short in duration, lasting a few hours each, over a period of days to weeks.	EIA would be required to cover the full environmental impacts associated with this option if selected.
17) Grounding of partial jacket at inshore site – 113 m water depth, at Hille near Aker Stord, Norway.	Long-term presence of jacket at inshore fjord location and resulting visual and noise impact on local communities.	Communities.	3	2	L	Method statements from removal contractors.	-	Inshore demolition will be performed in an existing set down location in an already industrialised area therefore the visual impacts from such an activity are considered to be very small. If necessary, a possible noise abatement measure could be to limit operations to normal daytime hours.	-
Potential impacts from leaving jacket footings *in situ*									
18) Physical presence of jacket footings left *in situ*.	Reef effect, leading to potential sheltering benefit to fish in surrounding area. Potential impacts: change in species composition, habitat, etc.	Benthos, fish, commercial fishing, stakeholders.	5	B	L	ES Environmental baseline description. Size of the Murchison jacket and volume of enclosed water.	Number and species of fish associated with the platform.	-	-

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
19) Physical presence of jacket footings left *in situ*.	Commercial consequences of snagging fishing gear on the jacket footings.	Commercial fishing, stakeholder.	4	3	M	Murchison Platform fishing risk analysis Commercial fisheries – Socioeconomic impact study ES Environmental baseline description.	-	Notice to Mariners, Kingfisher, Fishsafe. FLTC.	Environmental Management Plan.
20) Physical presence of jacket footings left *in situ*.	Loss of access for commercial fisheries.	Commercial fishing.	5	1	L	Commercial fisheries – Socioeconomic impact study.	-	-	-
21) Physical presence of jacket footings left *in situ*.	Release of contaminants from degrading metal footings and anodes which may contain components toxic to marine life.	Sediments, water column, plankton, benthos, fish.	1	1	L	Pre-decommissioning environmental baseline survey report.	-	-	-
22) Long term degradation of footings leading to falling jacket members and structures.	Physical disturbance to the drill cuttings pile potentially releasing toxic contaminants to the water column and seabed, which may impact pelagic and demersal species.	Sediments, water column, benthos, fish, plankton, stakeholders.	3	2	L	Pre-decommissioning environmental baseline survey report ES Environmental baseline description Murchison Drill Cuttings Modelling	-	-	-

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
23) Power generation for new manufacture to replace recyclable material left on the seabed.	Energy use leading to atmospheric emissions.	Use of resources, atmosphere, cumulative, stakeholders.	5	1	L	Energy and emissions report. Murchison Platform materials inventory.	-	-	-
Emergency and non-routine events relating to jacket decommissioning									
24) Large dropped objects, e.g. jacket, jacket sections.	Physical disturbance to the seabed and drill cuttings pile potentially releasing toxic contaminants to the water column and seabed, which may impact pelagic and demersal species.	Sediments, benthos, fish, commercial fishing, transboundary, stakeholders	1	3	L	Pre-decommissioning environmental baseline survey report ES Environmental baseline description Murchison Drill Cuttings Modelling	-	Defined lifting procedures. Vessel audits to ensure that all lifting equipment is with safety testing.	Operational procedures.

Table B.5: Pipeline decommissioning: pipeline PL115

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Potential impacts associated with pipeline decommissioning									
Rock-placement over exposed sections of the pipeline and remove spool pieces at pipeline ends [PL115: Duration= 12 days]									
1) Rock-placement over exposed sections of pipeline and pipeline ends.	Rock-placement leading to a modification of natural seabed characteristics and seabed habitat.	Sediments benthos, fish.	5	2	M	Murchison subsea and pipeline assets decommissioning report. Pre-decommissioning environmental baseline survey report ES Environmental baseline description	-	Procedures to minimise rock material placement. MCAA licence application.	Environmental Management Plan.
2) Rock-placement over exposed sections of pipeline and pipeline ends.	Physical disturbance causing suspension of material.	Sediment, water column, benthos, fish.	5	2	M	Murchison subsea and pipeline assets decommissioning report. Pre-decommissioning environmental baseline survey report ES Environmental baseline description	-	Procedures to minimise rock material placement. MCAA licence application.	Environmental Management Plan.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
3) Rock-placement over exposed sections of pipeline and pipeline ends.	Generation of underwater noise causing potential disturbance to marine life	Fish, marine mammals, cumulative.	3	2	L	Murchison subsea and pipeline assets decommissioning report. ES Environmental baseline description. Underwater noise impact assessment.	-	Rock-placement is likely to produce noise, however, measurements of rock-placement from a fall pipe rock-placement vessel found no evidence that the rock-placement itself contributed to the noise level from the vessel (Nedwell and Edwards, 2004).	Environmental Management Plan.
4) Physical presence of rock material.	Commercial consequences of snagging fishing gear on rock.	Commercial fishing, stakeholder, cumulative.	3	2	L	Murchison Platform fishing risk analysis. Commercial fisheries – Socio-economic impact study. ES Environmental baseline description.	-	Notice to Mariners, Kingfisher, Fishsafe. FLTC. Careful construction of the rock covering using correct size of rock.	Environmental Management Plan.

Table B.6: Bundle decommissioning: bundles PL123, PL124, PL125

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Potential impacts associated with bundles (x3) decommissioning									
Bundles – all options (excluding leave *in situ* – no operations required)									
1) Power generation for vessel operations.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
2) Vessel discharges e.g. sewage.	Release of contaminants leading to deterioration in seawater quality and localised increase in BOD around the discharge point.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
3) Power generation for dismantling structures inshore.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
4) Power generation for onshore transportation of recovered material to recycling site or landfill facility.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
Full removal of bundle in sections (Cut and lift) [Bundles = 90 days (including 2 weeks underwater cutting]									
4) Cut bundle at into sections using hydraulic shears.	Physical disturbance to seabed.		1	1	L	ES Environmental baseline description Pre-decommissioning environmental baseline survey report	-	-	-

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
5) Install hydraulic clamps on a spreader to the bundle sections and lift sections onto the vessel.	Physical disturbance to seabed.		1	1	L	ES Environmental baseline description. Pre-decommissioning environmental baseline survey report.	-	-	-
6) Removal of bundle PL125 which is covered by some drill cuttings where it connects to Murchison Platform.	Physical disturbance to the drill cuttings pile potentially releasing toxic contaminants to the water column and seabed, which may impact pelagic and demersal species.	Sediments, water column, benthos, plankton, fish, transboundary, stakeholders.	4	3	M	Pre-decommissioning environmental baseline survey report. Murchison subsea and pipeline assets decommissioning report. ES Environmental baseline description.	-	-	-
Potential impacts from completely removing bundles									
7) Complete removal of bundles.	Reopening the area previously occupied by the bundles to commercial fishing.	Commercial fishing.	5	B	L	Murchison pipeline fishing risk analysis. Commercial fisheries – Socioeconomic impact study. ES Environmental baseline description.	-	Post-decommissioning debris clearance operations to ensure the seabed is clear of any materials that could lead to snagging of fishing gear.	Environmental Management Plan

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Emergency and non-routine events relating to bundle decommissioning									
8) Accidentally dropped sections of bundles during removal operations.	Physical disturbance caused by bundle section landing on the seabed and suspension of sediment into the water column.	Sediments, benthos, fish.	3	1	L	ES Environmental baseline description. Pre-decommissioning environmental baseline survey report.	-	Post-decommissioning debris clearance operations.	Environmental Management Plan

Table B.7: Decommissioning of Murchison subsea wells

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Murchison Subsea Wells									
1) Power generation for vessel operations.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
2) Vessel discharges e.g. sewage.	Release of contaminants leading to deterioration in seawater quality and localised increase in BOD around the discharge point.		5	1	L	Refer to Table B.1 - The use of vessels, and offshore transportation, during all types of offshore operations.			
3) Power generation for dismantling structures inshore.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
4) Power generation for onshore transportation of recovered material to recycling site or landfill facility.	Energy use leading to atmospheric emissions.		5	1	L	Refer to Table B.9 - Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore.			
5) Discon-nection and recovery of protective structures and guide bases.	Physical disturbance to seabed and suspension of sediment into the water column.	Sediment, water column, benthos, fish, plankton.	1	1	L	ES Environmental baseline description Pre-decommissioning environmental baseline survey report.	-	-	-

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
6) Discon-nection and recovery of protective structures and guide bases.	Planned release of fluids from wellhead leading to deterioration in water quality in vicinity of discharge.	Water column, fish, plankton, transboundary.	1	1	L	EDC Scope and interfaces	-	Chemicals existing within the wellhead will be covered within the relevant discharge permit at the time of decommissioning.	-
Emergency and non-routine events relating to wellhead decommissioning									
7) Dropped objects.	Physical disturbance caused by object landing on the seabed and suspension of sediment into the water column.	Sediments, benthos, fish.	3	1	L	ES Environmental baseline description Pre-decommissioning environmental baseline survey report	-	Post-decommissioning debris clearance operations.	-

Table B.8: Drill Cuttings Pile Management

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Potential impacts associated with the cuttings pile management options									
1) Leave *in situ* and do nothing.	Leaching of contaminants including hydrocarbon and metals into the water column from an undisturbed cuttings pile.	Sediments, water column, benthos, fish, plankton, cumulative impacts, transboundary, stakeholders.	3	2	L	Pre-decommissioning environmental baseline survey report. UKOOA drill cuttings JIP final report 2002. Modelling long-term effects of cuttings pile. Drill Cuttings Pile Management Options Environmental Assessment Report.	-	On-going long-term monitoring programme.	Environmental Management Plan.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
2) Leave *in situ* and do nothing.	Long-term pile presence and contaminant persistence leading to continued impact on sediment quality and benthic communities from an undisturbed cuttings pile.	Sediments, benthos, fish, stakeholders, commercial fishing, cumulative impacts, stakeholders.	5	1	L	Pre-decommissioning environmental baseline survey report. UKOOA drill cuttings JIP final report 2002. Modelling long-term effects of cuttings pile. Drill Cuttings Pile Management Options Environmental Assessment Report.	-	On-going long-term monitoring programme.	Environmental Management Plan.

Table B.9: Deconstruction, disposal, manufacture and recycling of materials on or near-shore

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Potential impacts associated with deconstruction, disposal, manufacture and recycling of materials on or near-shore									
1) Dismantling structures at an inshore location prior to transfer to an onshore dismantling yard.	Dust and noise generation from cutting structures which may have harmful impacts to the inshore marine environment.	Atmosphere, communities, water column, plankton, sediments, benthos.	3	2	L	Facilities for onshore receipt of decommissioning structures. Methods statements from removal contractors. Murchison Platform materials inventory.	-	CNRI to audit contractor's yards to ensure appropriate licences and processes are in place to manage risk.	-
2) Power generation for dismantling structures inshore.	Energy use leading to atmospheric emissions of CO_2 and VOC which may contribute to climate change; emissions of NO_x and SO_x which may contribute to acid rain.	Use of resources, Atmosphere, cumulative, transboundary, stakeholders.	5	1	L	Energy and emissions report.	-	Emissions will be minimised through the planning of material movements and decommissioning contractors will be audited to ensure adequate maintenance of equipment.	Environmental Management Plan.
3) Dismantling structures/ recovered material at an onshore dismantling yard.	Generation of dust and noise in air which may have harmful effects to onshore environment.	Atmosphere, communities.	3	2	L	Facilities for onshore receipt of decommissioning structures. Methods statements from removal contractors. Murchison Platform materials inventory.	-	-	-

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
4) Presence of marine growth on jacket structure at inshore site.	Potential loss of organic matter to inshore marine environment.	Sediments, water column, benthos, fish, stakeholders.	2	2	L	Murchison marine growth report Facilities for onshore receipt of decommissioned structures.	Inshore dismantling location unknown.	Comply with regulations / restrictions at the inshore site.	Identify the permit requirements and restrictions at the potential onshore dismantling yards identified in Noble Denton report.
5) Onshore cleaning marine growth from jacket, conductors, using high pressure jet cleaner.	Odour generation from decay of organic matter.	Atmosphere, communities, stakeholders.	3	3	M	Murchison marine growth report 2010.	Time required to remove marine growth.	-	Environmental Management Plan.
6) Onshore disposal of marine growth.	Reduced capacity of disposal facilities, odour from organic material decay.	Use of landfill capacity, atmosphere, communities, stakeholders.	3	2	L	Murchison marine growth report 2010.	UKOOA JIP disposal of marine growth during decommissioning.	Selection of appropriate disposal site.	Environmental Management Plan.
7) Power generation for onshore transportation of recovered material to recycling site or landfill facility.	Energy use leading to atmospheric emissions of CO_2 and VOC which may contribute to climate change; emissions of NO_x and SO_x which may contribute to acid rain.	Use of resources, atmosphere, cumulative impacts, stakeholders.	5	1	L	Energy and emissions report.	-	Emissions will be minimised through the planning of material movements and decommissioning contractors will be audited to ensure adequate maintenance of equipment.	-

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
8) Power generation for recycling / reprocessing	Energy use leading to atmospheric emissions of CO_2 and VOC which may contribute to climate change; emissions of NO_x and SO_x which may contribute to acid rain.	Use of resources, atmosphere, cumulative, transboundary.	5	1	L	Energy and emissions report.	-	Emissions will be minimised through the planning of material movements and decommissioning contractors will be audited to ensure adequate maintenance of equipment.	-
9) Landfill disposal of non-recyclable materials.	Reduced capacity of disposal facilities.	Use of landfill capacity.	1	1	L	Murchison Platform materials inventory.	-	Waste management strategy for decommissioning Project waste management plan. Audit of waste management contractors.	Environmental Management Plan. Waste management plan.
11) Treatment and disposal of hazardous waste (including exempt NORM waste).	Reduced capacity of disposal facilities, i.e. landfill.	Energy use. Landfill capacity. Stakeholders.	5	1	L	NORM File Note Hazardous Material (Oily Solid Wastes) File Note.	Actual quantities of hazardous material	Conduct cleaning of pipelines and topsides vessels offshore to minimise the quantities of hazardous materials brought back on shore. SHE-PRO-332 Management of NORM. SHE-PRO-315 Waste Management. Selection of appropriate landfill site.	Conduct Offshore Hazardous material survey and Radiological Survey. Identify Potential Yard Restrictions.
12) Treatment and disposal of non-exempt NORM.	Reduced capacity and number of disposal facilities that treat non-exempt NORM.	Energy use. Atmospheric emissions. Stakeholders.	3	2	L	CNRI NORM File Note.	Actual quantities of NORM.	Conduct cleaning of pipelines and topsides vessels offshore to minimise the quantities of NORM brought back on shore. SHE-PRO-332 Management of NORM. Selection of appropriate disposal facilities.	Conduct Offshore Radiological Survey. Identify Potential Yard Restrictions.

Aspect	Potential Impact	Potential Receptors	Likelihood	Severity	Significance	Data available	Data Gaps	Mitigation / Prevention / Control / Comment	Action / Response
Emergency and non-routine events									
13) Unidentified non-exempt NORM mobilised onshore.	NORM transferred to unauthorised site.	Exposure of radioactive waste to land and members of public Stakeholders.	2	3	L	-	-	SHE-PRO-332 Management of NORM. Competent RPS offshore to identify and handle NORM.	-

Appendix C
Energy Use and Atmospheric Emissions – Supporting Information

Operations

An inventory of operations for the recommended decommissioning options is provided within Tables C-1 to C-7. These summarise the anticipated types of operations to be conducted. The operations may not occur in the order listed here and may be conducted once or a number of times.

Table C-1: Inventory of operations for topsides decommissioning

Operation
Topsides removal by cut and lift (applies to Methods A, B and C)
Manufacture of temporary steelwork
Mobilisation of vessels
Preparation of topsides modules
HLV lift of topsides modules
HLV sailing to offloading location in sheltered waters
Mooring of cargo barge to HLV
Transfer of modules from HLV to cargo barge
Transportation and offloading of recovered modules to shore
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill
Topsides removal by piece small deconstruction
Manufacture of temporary steelwork
Mobilisation of vessels and equipment
Piece-small offshore deconstruction of topsides modules M2 to M7, M10 to M14, M17 and M19
Removal of flare boom by HLV lift
Mobilisation of flotel
Piece-small offshore deconstruction of topsides modules M8, M9, M15, M16 and M91
HLV lift of accommodation block and MSF
Transportation of recovered modules to inshore
Inshore deconstruction of recovered material
Demobilisation of vessels and equipment
Recovered material to recycling site or landfill

Source: CNRI (2011b)

Table C-2: Inventory of operations for jacket decommissioning

Operation
Jacket full removal by flotation in one piece
Manufacture of temporary steelwork
Mobilisation of vessels
Removal of drill cuttings pile
Modifications to buoyancy tanks
Preparation of jacket
BTA transportation to field
BTA installation
Float up of jacket and footings
Tow to inshore
Inshore deconstruction
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill
Jacket partial removal by cut and lift (applies to Methods A, B and C)
Manufacture of temporary steelwork
Mobilisation of vessels
Preparation of jacket top sections
HLV removal of jacket top sections
Transportation and offloading of jacket top sections to shore
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill
Jacket partial removal by flotation
Manufacture of temporary steelwork
Mobilisation of vessels
Modifications to buoyancy tanks
Preparation of jacket
BTA transportation to field
BTA installation
Float up of jacket
Tow to inshore
Inshore deconstruction
Demobilisation of vessels
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: CNRI (2011b)

Table C-3: Inventory of operations for pipeline decommissioning (pipeline and bundles, as applicable)

Operation
Pipelines – bury exposed sections only, remove spools and bury ends – by rock-placement
Mobilisation of vessels and equipment
Acoustic and visual inspection
Water jet rock-placement to expose line
Remove mattresses
Rock-placement exposed sections
As-left survey
Post-decommissioning survey
Demobilisation of vessels
Transportation of recovered material to shore
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: Atkins (2011)

Table C-4: Inventory of operations for platform approaches decommissioning

Operation
Murchison and Dunlin spoolpieces – full recovery
Mobilisation of vessels and equipment
Visual inspection
Drill lift holes and insert lift anchor and wires
Lift and cut pipeline
As-left survey
Demobilisation of vessels
Transportation of recovered material to shore
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: Atkins (2011)

Table C-5: Inventory of operations for subsea wells decommissioning

Operation
Subsea wellheads – full removal
Mobilisation of vessels and equipment *
P&A well 211/19-2.
Disconnection and recover of protective structures and guide bases
Visual inspection
Transportation of recovered material to shore
Dismantling of recovered material
Recovered material to recycling site or landfill

Notes: * P&A of well 211/19-2 was not included within the Atkins (2011) estimates of vessel and equipment use. The operation is included in this table for completeness but data was not available to include it in the energy and emissions calculations. It is not expected that the conclusions of this assessment are affected by this omission.

Source: Atkins (2011)

Table C-6: Inventory of operations for platform wells decommissioning

Operation
Platform conductors
Mobilisation of vessels and equipment
Cutting conductors at -125m
Recovery of conductors
Visual inspection
Cleaning marine growth from conductors
Transportation of recovered material to shore
Dismantling of recovered material
Recovered material to recycling site or landfill
Platform wellheads
Mobilisation of vessels and equipment
Disconnection and recovery of tubing, xmas trees and wellheads
Visual inspection
Transportation of recovered material to shore
Dismantling of recovered material
Recovered material to recycling site or landfill

Source: CNRI (2011a)

Table C-7: Inventory of operations for drill cuttings management

Operation
Drill cuttings pile – leave in situ
No operations

Source: CNRI (2012a)

Energy Use and Emission Factors

Table C-8: Emission factors

Material	Energy consumption (GJ/tonne)	Gaseous emissions (kg/tonne)				Source
		CO_2	NO_x	SO_2	CH_4	
Recycling of materials						
Standard steel	9	960	1.6	3.8	ND	IoP (2000)
Aluminium	15	1,080	1.3	17	ND	IoP (2000)
Copper	25	300	ND	120	ND	IoP (2000)
Zinc	10	480	ND	ND	ND	University of Bath (2008)
New manufacture of materials						
Standard steel	25.0	1,889	3.5	505	ND	IoP (2000)
Aluminium	215.0	3,589	4.1	24.9	ND	IoP (2000)
Copper	100.0	7,175	20	200	ND	IoP (2000)
Zinc	65.0	24	0.3	3.7	ND	IoP (2000)
Cement	1.0	880	5.4	0.1	ND	IoP (2000)
Aggregate	0.1	5	ND	ND	ND	IoP (2000)
Wood	5.2	ND	ND	ND	ND	IoP (2000)
Rock wool	6.8	680	0.1	2	ND	IoP (2000)
Rubber	100.0	ND	ND	ND	ND	IoP (2000)
Fuel use						
Marine diesel	43.1	3,200	59.0	4	0.270	IoP (2000); UKOOA (2002)
Aviation fuel	46.1	3,200	12.5	4	0.087	IoP (2000); UKOOA (2002)
Diesel fuel	44.0	3,180	40	1	ND	IoP (2000)
Turbine generator	44.0	3,200	13.5	4	0.328	EEMS (2008)
Engine generator	44.0	3,200	59.4	4	1.800	EEMS (2008)
Onshore deconstruction						
Overall dismantling	1.15	ND	ND	ND	ND	IoP (2000)

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Table C-9: Energy consumption factors - vessel fuel consumption

Vessel	Energy consumption (tonnes/day)				Source / comments
	In port	In transit	Working	Waiting on weather	
Heavy lift vessel (HLV)	25	25	30	30	IoP (2000) and CNRI (2011b). Applicable to cut and lift Method A.
	23	301	61	40	IoP (2000) and CNRI (2011b). Applicable to cut and lift Method B.
	25	50	40	50	IoP (2000) and CNRI (2011b). Applicable to cut and lift Method C.
	25	50	40	50	IoP (2000) and CNRI (2011b). Applicable to piece small deconstruction.
Supply vessel	2	10	5	5	IoP (2000)
Standby vessel	1	8	4	4	IoP (2000) factors for a safety vessel. For the CNRI standby vessel, these factors are more appropriate than the IoP (2000) factors for a standby vessel.
Support vessel	2	26	18	9	IoP (2000) factors for a multi-support vessel (MSV)
MSV	2	26	18	9	IoP (2000)
Cargo barge tug	1	10	17	17	IoP (2000) factors for cargo barge tug. No value provided for waiting on weather; therefore, assumed similar to working.
Anchor handling vessel (AHV)	2	50	5	30	IoP (2000)
Construction support vessel (CSV)	2	26	18	9	IoP (2000) factors for MSV
Survey vessel	3	22	18	10	IoP (2000) factors for DSV
Guard vessel	1	8	4	4	IoP (2000) factors for safety vessel
Floating crane	10	40	50	50	IoP (2000)
DSV	3	22	18	10	IoP (2000)
Lay barge	2	8	15	15	IoP (2000) factors for pipeline vessel
Reel lay vessel	3	19	19	25	IoP (2000) factors for pipe recovery vessel
Trenching vessel	2	8	15	15	IoP (2000) factors for pipeline vessel; assumed similar fuel usage.
Rock-placement	2	8	15	15	IoP (2000)