Supplier	**Xodus**
Ref Number (Project/Job/PO)	**A-301524-S00**
Supplier Document Number	**A-301524-S00-EIAS-004**
Client Document Number	**XOD-DUN-HSE-RPT-00005**

Dunlin Alpha Decommissioning Environmental Appraisal Report

APPROVAL STATUS (To be completed by FEL)		**SIGNED**	**DATE**
1	Not Approved		
2	Approved Subject To Comments		
3	Approved	PL	2/8/18
4	For Information Only		

REVISION HISTORY					
A04	02/08/18	Issued for Client Use	ND	KC	KC
A03	12/07/18	Issued for Client Use	KC	PTa	KC
A02	15/06/18	Issued for Client Use	LW	KC	KC
A01	22/05/18	Issued for Client Use	LW	KC	KC
R02	27/04/18	Issued for Client Review	LW	ND	ND
R01	02/04/18	Issued for Client Review	LW/DR	KC	KC
Revision	**Date**	**Description**	**Originator**	**Checked**	**Approved**

This Dunlin Alpha Decommissioning Environmental Appraisal Report is a supporting document to the Draft Decommissioning Programme alongside the Comparative Assessment Report and other documentation, available on FEL website (http://www.fairfield-energy.com).

Contents

Acronyms

%	Percent
£	Pound sterling
°	Degrees
°C	Degrees Celsius
µm	Micrometre
$\mu g g^{-1}$	Microgram per gram
AIS	Automatic Identification System
ALARP	As Low as Reasonably Practicable
ANDOC	Anglo Dutch Offshore Concrete
AORP	Attic Oil Recovery Project
BAOAC	Bonn Agreement Oil Appearance Code
BEIS	Department for Business, Energy and Industrial Strategy
BODC	British Oceanographic Data Centre
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
CCTR	Cell Contents Technical Report
CGBS	Concrete Gravity Base Substructure
Cm	Centimetre
CO_2	Carbon Dioxide
DECC	Department of Energy and Climate Change (now BEIS)
DFGI	Dunlin Fuel Gas Import
DP	Decommissioning Programme
DPI	Dunlin Power Import
DSV	Dive Support Vessel
EA	Environmental Appraisal
EBS	Environmental Baseline Survey
EIA	Environmental Impact Assessment
EIF	Environmental Impact Factor
EMS	Environmental Management System
EPS	European Protected Species
EU	European Union
EUNIS	European Nature Information System
FEL	Fairfield Energy Limited
Ft	Feet
ft^3	Cubic feet
g/m^2	Grams per metre squared
g/m^3	Grams per metres cubed
Helideck	Helicopter deck
HLV	Heavy Lift Vessel

HRA	Habitats Regulations Assessment
HSE	Health and Safety Executive
ICES	International Council for the Exploration of the Sea
IMO	International Maritime Organisation
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organisation for Standardisation
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for Conservation of Nature
JNCC	Joint Nature Conservation Committee
kg	Kilogram
km	Kilometre
km^2	Square kilometre
km^3	Cubic kilometre
LAT	Lowest astronomical tide
LoD	Limit of Detection
LSA	Low specific activity
m	Metre
m/s	Metres per second
m^2	Square metre
m^3	Cubic metre
MCDA	Multi Criteria Decision Analysis
MCZ	Marine Conservation Zone
MEMW	Marine Environmental Modelling Workbench
MMO	The Marine Management Organisation
MPA	Marine Protected Area
MSF	Modular Support Frame
MSH	Make Safe and Handover
Navaid	Navigation Aid
NCMPA	Nature Conservation Marine Protected Area
Nm	Nautical Miles
NORM	Naturally Occurring Radioactive Material
OGA	UK Oil and Gas Authority
OGUK	Oil and Gas UK
OPEP	Oil Pollution and Emergency Plan
OPF	Organic Phase Fluids
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo Paris Convention
P&A	Plug and Abandonment
PEC	Predicted effect concentration
pH	Potential hydrogen

PMF	Priority Marine Feature
PNEC	Predicted no-effect concentration
SAC	Special Area of Conservation
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SCI	Site of Community Importance
SCOS	Special Committee on Seals
SEA	Strategic Environmental Assessment
SIMOPs	Simultaneous operations
SMRU	Sea Mammal Research Unit
SNH	Scottish Natural Heritage
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
THC	Total Hydrocarbon Content
TOC	Total Organic Carbon
TOM	Total Organic Matter
UK	United Kingdom
UKBAP	United Kingdom Biodiversity Action Plan
UKCS	United Kingdom Continental Shelf
UKOOA	United Kingdom Offshore Operators Association
UNESCO	United Nations Educational, Scientific and Cultural Organization
VMS	Vessel Monitoring System

Non-Technical Summary

Introduction

Fairfield Betula Limited and Fairfield Fagus Limited (collectively termed Fairfield), wholly owned subsidiaries of Fairfield Energy Limited, are the operators of the Dunlin, Merlin and Osprey fields (the 'Greater Dunlin Area'), located in United Kingdom Continental Shelf (UKCS) Block 211/23 of the northern North Sea. The Dunlin field lies approximately 137 km from the nearest landfall point, 197 km north east of Lerwick and 508 km north east of Aberdeen. The field sits 11 km from the United Kingdom (UK)/Norway median line and in a water depth of approximately 151 m (Figure 1). The Osprey field is a subsea tie-back located 6 km to the north-north west of the Dunlin Alpha installation and the Merlin field is also a subsea tie-back, located 7 km to the west-north west of the Dunlin Alpha installation. Production at the Dunlin, Merlin and Osprey fields ceased in June 2015 and Fairfield is now in the process of decommissioning all infrastructure associated with the Greater Dunlin Area. This Non-Technical Summary provides an overview of the Environmental Appraisal that has been prepared specifically for the proposed decommissioning of Dunlin Alpha.

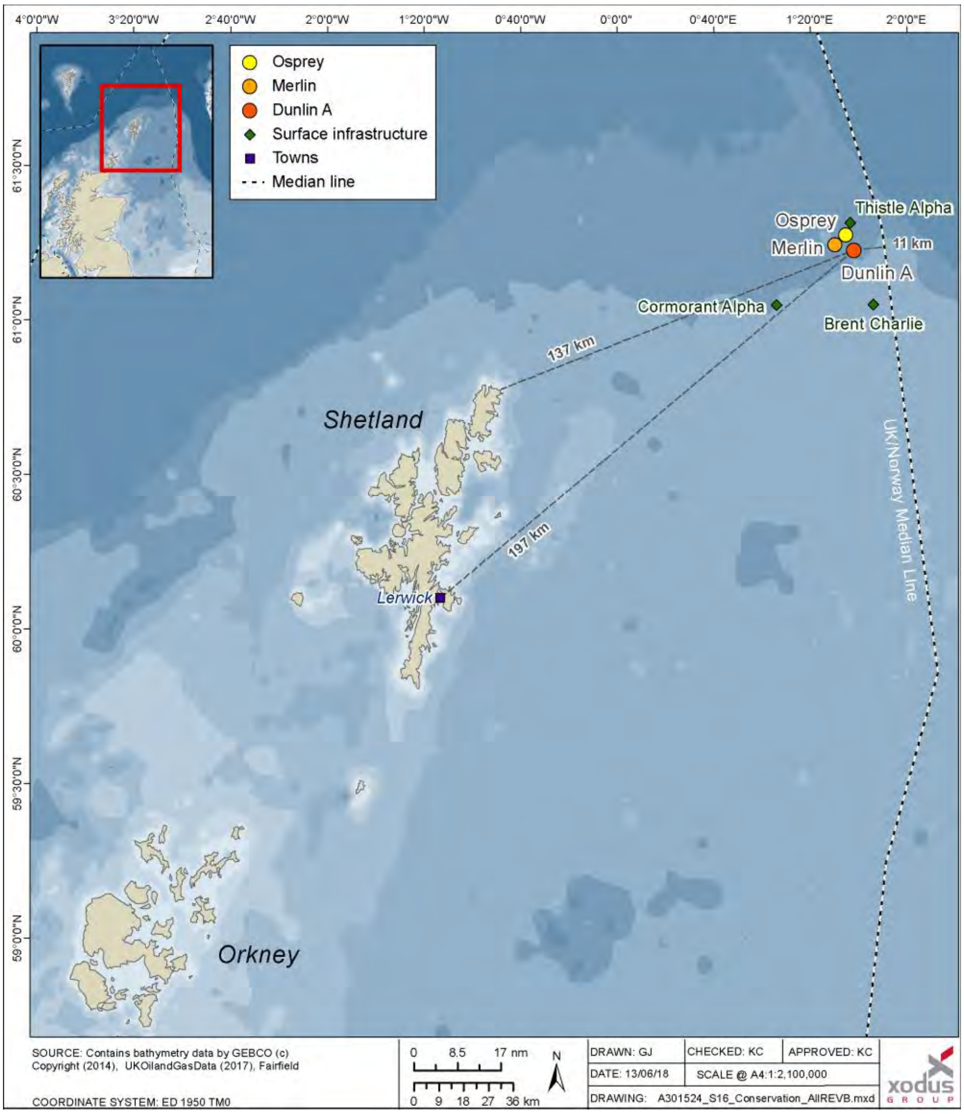


Figure 1 Location of Dunlin, Merlin and Osprey Fields

Dunlin Alpha is a four-leg installation, constructed on a concrete gravity base substructure (CGBS), with a steel box girder-based topsides supporting two levels of modules.

The scope of the Dunlin Alpha Decommissioning Programme covers:

- The Dunlin Alpha topsides;
- CGBS:
    - Transitions;
    - Concrete legs;
    - Base caisson;
    - Cell contents;
    - Conductors;
    - Conductor Guide Frames; and
- Drill cuttings.

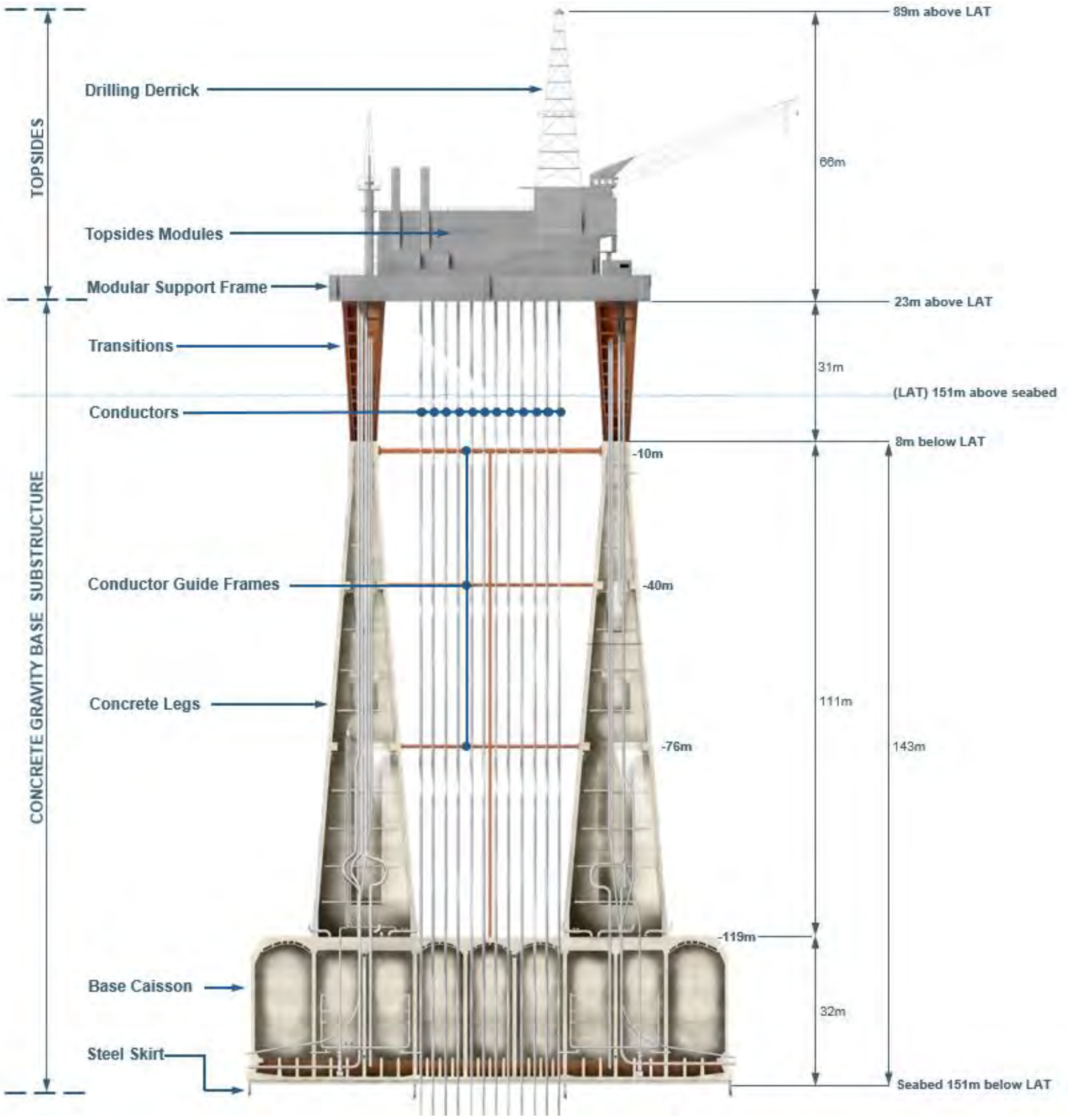


Figure 2 Dunlin Alpha installation

Options for Decommissioning the Dunlin Alpha Installation

The Dunlin Alpha supported production from the Dunlin, Merlin and Osprey fields. Following the end of production from these fields in June 2015, options to re-use the infrastructure *in situ* for future hydrocarbon developments have been considered, but to date none have yielded a viable commercial opportunity. There are a number of reasons for this, including the absence of remaining hydrocarbon reserves in the vicinity of Dunlin Alpha. It is now considered unlikely that any opportunity to reuse the infrastructure will be feasible. As such, there is no reason to delay decommissioning of the Dunlin Alpha installation in a way that is safe and environmentally and socio-economically acceptable. In line with the latest Department for Business, Energy and Industrial (BEIS) Strategy guidelines on decommissioning, Fairfield has committed to decommissioning Dunlin Alpha as described below.

In accordance with the latest guidance from BEIS, Fairfield proposes to recover the topsides to shore. At this stage, Fairfield has not determined the specific method by which the topsides will be removed and returned to shore; the project reference case is a reverse installation method, but the decision will depend to some degree on the proposals made by the eventual contractor. In all cases, the topsides will be fully removed to shore.

It is proposed that the CGBS is decommissioned *in situ* with the four transitions remaining in place and the concrete legs partially flooded to reduce the differential pressure across the CGBS cells groups. The transitions will be sealed with an appropriately galvanised steel roof, and a navigational aid (navaid) and navaid support frame would be installed on top of one of the transitions. This would have its internal walls coated and cathodic protection installed to reduce the corrosion rate. The conductors will be cut just above the lower guide frames and returned to shore along with the upper two guide frames. The lower guide frame will be left attached to the concrete legs.

It is proposed that the cell contents are decommissioned *in situ*. No intervention work is required to facilitate this decommissioning option.

As it is proposed to decommission the CGBS *in situ* and as the drill cuttings are below the OSPAR 2006/5 thresholds for leaching and persistence, it is the intention of Fairfield to leave the drill cuttings pile *in situ* with minimum disturbance. No intervention work is required on the drill cuttings to facilitate this decommissioning scenario.

Fairfield has followed the BEIS guidelines and undertaken a formal process called ‘Comparative Assessment’ for the elements of the project where full removal is not the adopted solution. The Comparative Assessment process allows for the development of a preferred decommissioning methodology, based on consideration of safety risk, environmental impact, technical feasibility, societal impacts and economic factors. For the Dunlin Alpha Decommissioning Project, the infrastructure for which Comparative Assessment was undertaken is shown in Table 1. To compare each option against the others to make a decision, Fairfield utilised a Multi Criteria Decision Analysis (MCDA) tool. This tool allows an assembled team to review the available data for each option and determine, using terms such as ‘neutral’, ‘stronger’, ‘much stronger’ and so on, how each option compares to the other. This comparison was undertaken using the five criteria described in the BEIS guidelines of safety, environmental, technical, societal and economic. The selected options from the Comparative Assessment process decision outcomes, supported by an appropriate amount of specialist study work, are summarised in Table 1.

Table 1 Description of Dunlin Alpha Decommissioning Activities

Infrastructure type	Subject of Comparative Assessment?	Decommissioning recommendation
Topsides	No	Full removal
CGBS	Yes	Leave *in situ*, including transitions – install navaid and cathodic protection
Cell Contents	Yes	Leave *in situ*
Drill Cuttings	No	Leave *in situ*

Project Description

Fairfield anticipates executing the Dunlin Alpha Decommissioning Programme activities in 2021; an indicative schedule for the work is shown in Figure 3. However, the specific timing of decommissioning activities will be agreed with BEIS and with the Health and Safety Executive and applications for all relevant permits and consents will be submitted and approval sought prior to activities taking place.

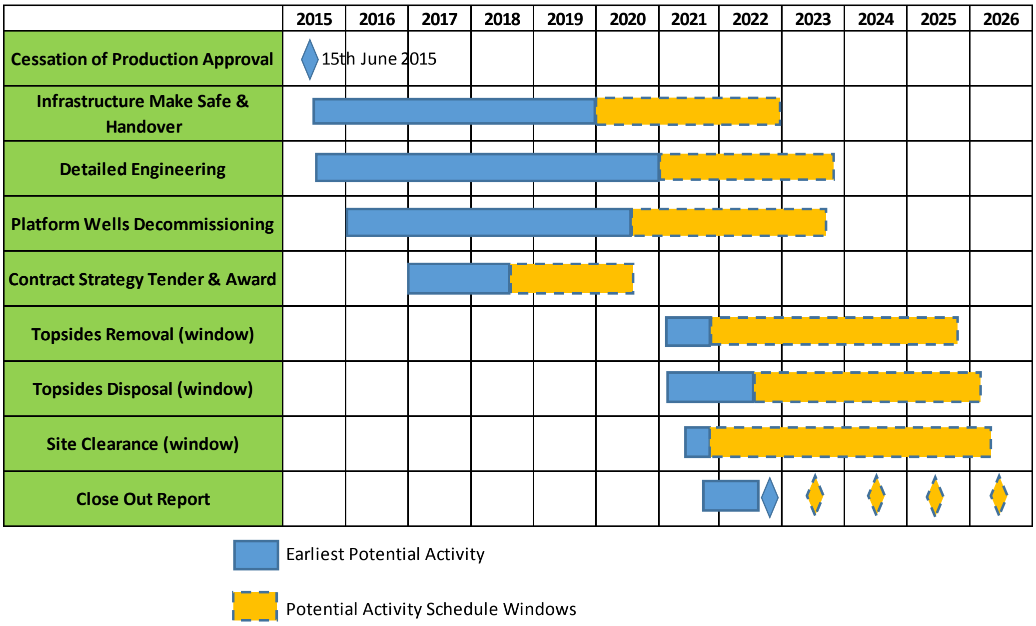


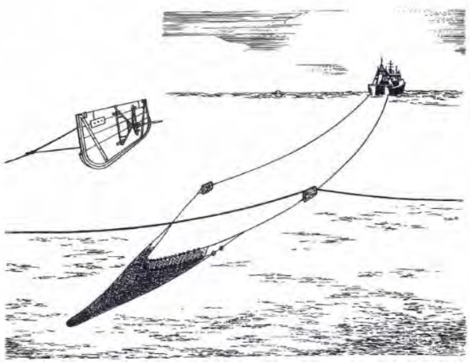
Figure 3 Indicative Schedule

Environment Description

Based on previous experience, studies (including Fairfield-commissioned surveys), review of scientific data and consultation, it has been possible to identify the current key environmental sensitivities in the Project area; these are summarised in Table 2.

Table 2 Summary of the Key Environmental Sensitivities of the Dunlin Area

Animals living on or in the seabed (benthos)
The habitat assessment undertaken for the Project determined the sediments to be mainly muddy sand and mixed sediment with some evidence of contamination in some areas. The visible animals found across the survey area included polychaete worms, crustaceans and molluscs. Species were generally considered to be intolerant of hydrocarbon contaminations. Surveys showed the seabed to host a relatively diverse range of species, with little variation across the area. 
Fish
 The fish populations in the Project area are characterised by species typical of the northern North Sea, including long rough dab, hagfish and Norway pout. Basking shark, tope and porbeagle are all also likely to occur in small numbers. The Project area is located within the spawning grounds of cod, haddock, Norway pout and saithe, meaning that these species use the area for breeding. Nursery grounds, where juvenile fish remain to feed and grow, for blue whiting, European hake, haddock, herring, ling, mackerel, Norway pout, spurdog and whiting are also found in the wider area.
Seabirds
The Project area is important for fulmar, northern gannet, great black-backed gull, Atlantic puffin, black-legged kittiwake and common guillemot for the majority of the year. Manx shearwaters are present in the vicinity of the Project area between the spring and autumn months. European storm petrels are present during September and November. Great skua, glaucous gull, Arctic skua and little auk may be present in low densities for the majority of the year.  The seasonal vulnerability of seabirds to oil pollution in the immediate vicinity of the Project area has been derived from Joint Nature Conservation Committee data; the months of March, July, October and November are those when seabird species in the Project area are considered most vulnerable to surface pollution. Overall annual seabird vulnerability is reported to be low.

Whales, dolphins and seals
 Spatially and temporally, harbour porpoises, white-beaked dolphins, minke whales, killer whales and white-sided dolphins are the most regularly sighted cetacean species in the North Sea. Given the distance to shore, species such as the bottlenose dolphin and grey and harbour seals are unlikely to be sighted in the Project area.
Conservation
None of the survey work undertaken in the Project area has identified any seabed habitats or species that are of specific conservation significance, apart from low numbers of juvenile ocean quahog, which is considered to be a threatened species. There are also no designated or proposed sites of conservation interest in the Project area; the closest designated site, the European Site of Community Importance 'Pobie Bank Reef' lies approximately 98 km to the south west of Dunlin, off the east coast of Shetland.
Fisheries and other sea users
Saithe and mackerel (often targeted by the larger pelagic vessels in January and February) are the key commercial species landed from the Project area. However, they are of relatively low value when compared to total landings into Scotland; combined, landings of these species from the wider area within which the Project sits comprise only 0.06% of the value of landings into Scotland. Other species of commercial value include megrim, cod and monks/anglers. There is very little shipping activity in the Project area, and no site of renewable or archaeological interest. There is also limited infrastructure related to other oil and gas developments. 

Impact Assessment

The Dunlin Alpha Decommissioning Programme environmental impact assessment has been informed by a number of different processes, including scoping with the Regulators and their statutory advisors, workshops with specialists, such as an ENVID workshop, and the Comparative Assessment process. Where potentially significant impacts have been identified, mitigation measures have been considered; these include both industry standard and project-specific measures. The intention is that such measures should remove, reduce or manage the potential impacts to a point where the impacts are not significant.

Those that were not assessed as key environmental sensitivities were scoped out. The decision on which issues required further study and assessment was based on the specific proposed activities and environmental sensitivities around the Dunlin Alpha installation, on a review of industry experience of decommissioning impact assessment and on an assessment of wider stakeholder interest informed in part by stakeholder engagement. This was captured during the ENVID process.

Table 3 presents the findings of the environmental impact assessment for the potentially significant impacts identified for the Project. The potential for cumulative and transboundary impacts is also considered.

Table 3 Details of the Potential Environmental Impact of the Proposed Activities

Key potential impacts assessed	Significance
Cell Contents – Gradual Release Over Time	
Impact assessment: The most credible scenario for release of cell contents over time is one occurring due to cracks in the concrete and communication paths opening up at existing pipework penetrations. This could result in a small release of mobile oil, water, chemicals, sediment and waxy residue. It is expected that up to a maximum of approximately 1,565 m^3 of mobile oil could be released from the cell contents over time. This could have a potential impact on plankton, fish, seabirds, cetaceans, benthos and result in bioaccumulation. **Cumulative**: It is possible that discharges from the cells could act cumulatively with releases from other assets in the area in the future to result in a negative impact to the surrounding environment. As a result of the water depth (151 m) and the release of such a volume occurring in small percentages over an extended duration (up to hundreds of years as the structure degrades), any discharge of mobile oil is expected to dissipate relatively rapidly and have no capacity to act cumulatively with discharges from other activities. **Transboundary**: The gradual release of mobile oil and other contents of the cells will be over a prolonged period of time and will be of a relatively small volume at any one time. With the small volumes, there is expected to be no transboundary impact. **Effects on protected sites**: Dispersal of any released contaminants will be such that there will unlikely be detectable interaction with any protected sites. As such, there is considered to be no Likely Significant Effect on SACs and SPAs and no impact on their conservation objectives or on site integrity through a release of contaminants from the cells.	Not significant
Cell Contents – Instantaneous Release	
Impact assessment: The main potential impact from an instantaneous release associated with the Dunlin Alpha is an early failure of a transition falling from the top of a CGBS leg. Although highly unlikely, this could see a steel transition falling through the water column onto the roof of CGBS base caisson. To understand the extent of any potential impact, oil spill modelling was undertaken. This showed that the area over which the hydrocarbons might disperse would be limited. This could have a potential impact on plankton, fish, seabirds, cetaceans, benthos and result in bioaccumulation. Given the limited release, there is expected to be no significant impact on the environment. The conditions in the offshore environment would also mean that any release would disperse relatively quickly.	Not significant

Key potential impacts assessed	Significance
Cumulative: Any hydrocarbon release in the Dunlin Alpha Decommissioning Project area is expected to dissipate within days. It is considered very unlikely that additional releases from other sources would occur in the same timeframe and produce a cumulative impact. **Transboundary**: Depending on prevailing wind conditions at the time of any release, it is possible that any cell contents that are released could cross into the Norwegian sector. However, the small volumes and the distance to the transboundary line (11 km) mean that the release would be widely dispersed to very low levels and it is unlikely there will be significant transboundary effects associated with an instantaneous release **Effects on protected sites**: Modelling of an instantaneous release of mobile oil from the cells has shown that it would be unlikely for this inventory to reach the shoreline; at worst, the very north-east coast of Shetland could receive a very small volume of oil depositing on the shoreline. As such, there is expected to be no mechanism for impacting protected sites.	
Drill Cuttings Disturbance	
Impact assessment: As the CGBS begins to degrade over time, there is the possibility that the drill cuttings on the roof of the base caisson and around the base of the CGBS could be disturbed by failing objects. The subsequent possible re-distribution and re-settling of the cuttings has the potential to impact upon the benthos in the vicinity of the Dunlin Alpha installation. **Cumulative**: Any hydrocarbon or chemical release in the Project area is expected to dissipate within days. It is considered very unlikely that additional releases from other sources would occur in the same timeframe and produce a cumulative impact. **Transboundary**: Disturbed drill cuttings will not cross the transboundary line (11 km to the east) and there will therefore be no transboundary impact. **Effects on protected sites**: Disturbance of the drill cuttings will result in spatially limited potential impacts and, given the location of the Dunlin Alpha installation, no impact on protected sites is expected.	Not significant
Physical Presence	
Impact assessment: The Dunlin Alpha decommissioning activities have the potential to impact upon other users of the sea. This may happen during the decommissioning activities themselves, when vessels are working in the field and transiting to shore occupy space, and after decommissioning should any infrastructure decommissioned *in situ* interact with activities such as fishing. The main long-term interaction with other users of the sea will be as a result of a 500 m safety zone that will remain around the Dunlin Alpha CGBS, which is proposed to be decommissioned *in situ*. The 500 m safety zone will see the continued exclusion of fisheries from the immediate area around the CGBS.	Not significant

Key potential impacts assessed	Significance
Cumulative: The small area of sea that would remain out of bounds to fisheries, especially in the context of the limited fishing effort in the Greater Dunlin Area, as a result of the Dunlin Alpha installation remaining *in situ* is not therefore likely to present a significant cumulative impact. **Transboundary**: The vessel presence is still regarded as relatively low, and there is no mechanism by which significant transboundary impacts could occur.	

Environmental Management

Beyond the main time period of decommissioning preparation and removal operations, the Project has limited activity associated with it (there are likely to be a small number of post-decommissioning/navigational surveys). The focus of environmental performance management for the Project is therefore to ensure that the activities that will take place during the limited period of decommissioning happen in a manner acceptable to Fairfield (and to stakeholders). The primary mechanism by which this will occur is through Fairfield's Environmental Management Policy and specifically through the associated Environmental Management System that Fairfield operates.

Fairfield senior management is responsible for ensuring that Fairfield's Environmental Management System is applied to all activities. To support this, a Project Health, Safety and Environment Plan will be developed which outlines how Health, Safety and Environment issues will be managed and how the policies will be implemented effectively throughout the Project. The Plan will apply to all work carried out on the Project, be it onshore or offshore. Performance will be measured to satisfy both regulatory requirements including compliance with environmental consents, as well as to identify progress on fulfilment of project objectives and commitments.

Fairfield has also developed a Waste Management Strategy for the Project, in order to describe the types of materials identified as decommissioning waste, and to outline the processes and procedures necessary to support the Decommissioning Programme for the Dunlin Alpha. The Waste Management Strategy details the measures in place to ensure that the principles of the Waste Management Hierarchy are followed during decommissioning (as shown in Figure 4).

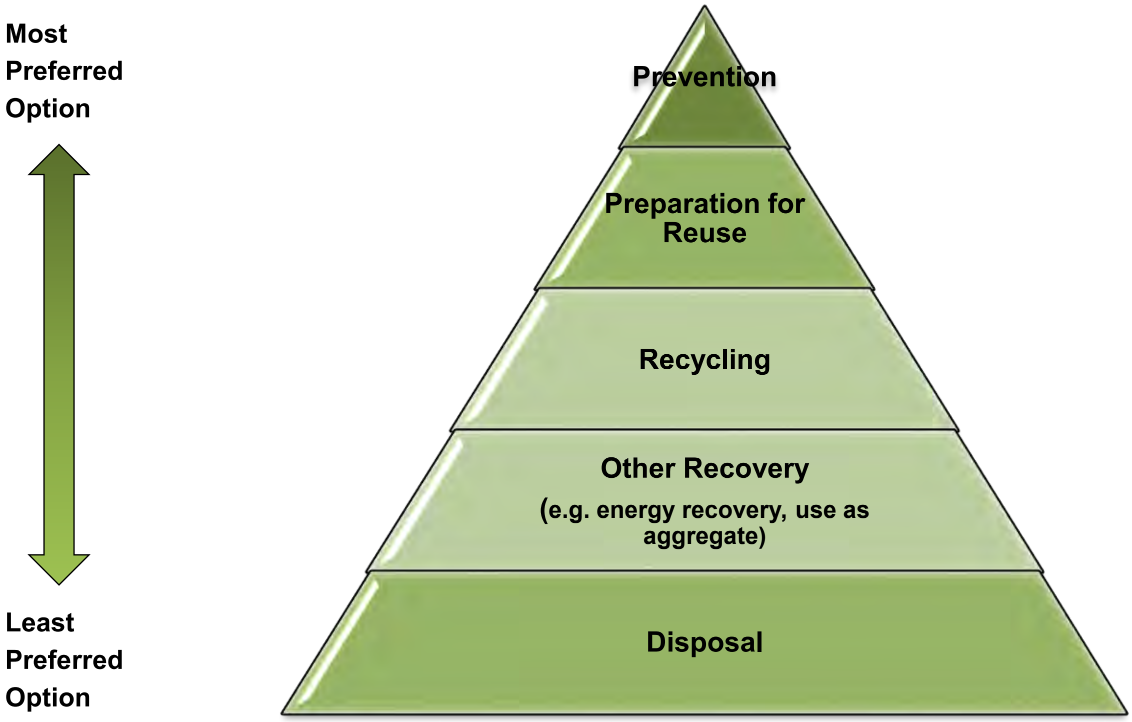


Figure 4 Waste Hierarchy

Conclusions

The planned operations have been rigorously assessed through the environmental impact assessment and Comparative Assessment processes, resulting in a set of selected options which are thought to present the least risk of environmental impact whilst satisfying safety, technical, societal and economic requirements. Based on the findings of the environmental impact assessment and the identification and subsequent application of the mitigation measures identified for each potentially significant environmental impact (which will be managed through Fairfield Environmental Management System), it is concluded that the Project will result in no significant environmental impact.

1. Introduction

1.1. The Greater Dunlin Area

Fairfield Betula Limited and Fairfield Fagus Limited (collectively termed Fairfield), wholly owned subsidiaries of Fairfield Energy Limited, are the operators of the Dunlin, Merlin and Osprey fields (the 'Greater Dunlin Area'), located in United Kingdom Continental Shelf (UKCS) Block 211/23 of the northern North Sea. The Dunlin field lies approximately 137 km from the nearest landfall point, 197 km north east of Lerwick and 508 km north east of Aberdeen. The field sits 11 km from the United Kingdom (UK)/Norway median line and in a water depth of approximately 151 m (Figure 1.1). The Osprey field is a subsea tie-back located 6 km to the north-north west of the Dunlin Alpha installation and the Merlin field is also a subsea tie-back, located 7 km to the west-north west of the Dunlin Alpha installation. A layout of the infrastructure associated with these fields, in the context of the wider area, is shown in Figure 1.2.

Production at the Dunlin, Merlin and Osprey fields ceased in June 2015 and Fairfield is now in the process of decommissioning all infrastructure associated with the Greater Dunlin Area. The decommissioning of the Dunlin, Merlin and Osprey subsea infrastructure has been considered separately from the Dunlin Alpha installation activities, and approval of the Decommissioning Programmes for that infrastructure has been received. In addition, planning for the decommissioning of the Dunlin to Cormorant Alpha Export Pipeline (PL5) is also being progressed. Fairfield is now preparing the necessary regulatory submissions for decommissioning of the Dunlin Alpha installation; this Environmental Appraisal report relates specifically to the activities associated with the proposed decommissioning of the Dunlin Alpha installation.

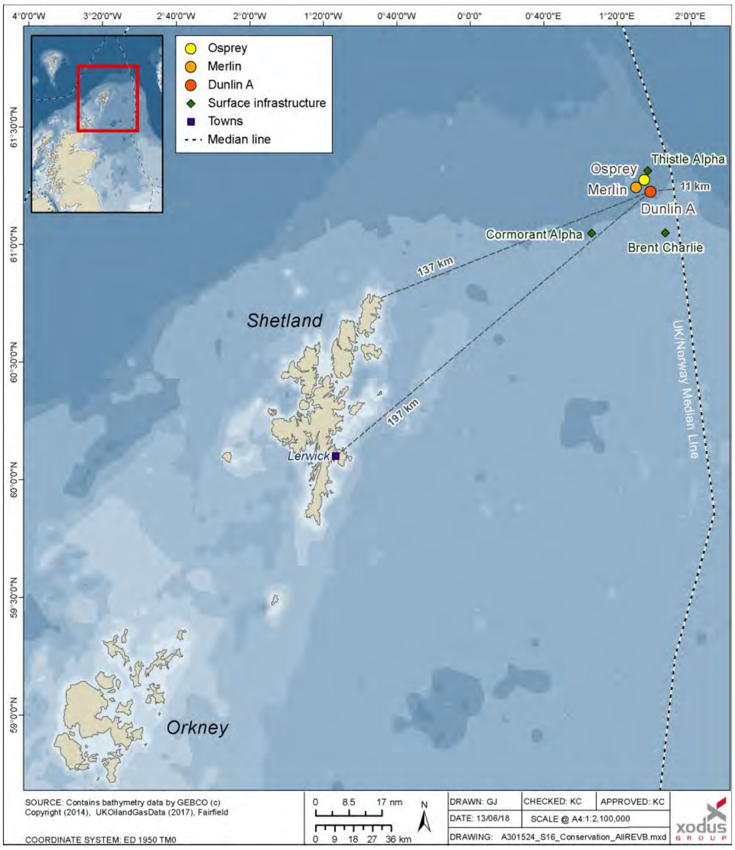


Figure 1.1 Location of the Dunlin, Merlin and Osprey Fields

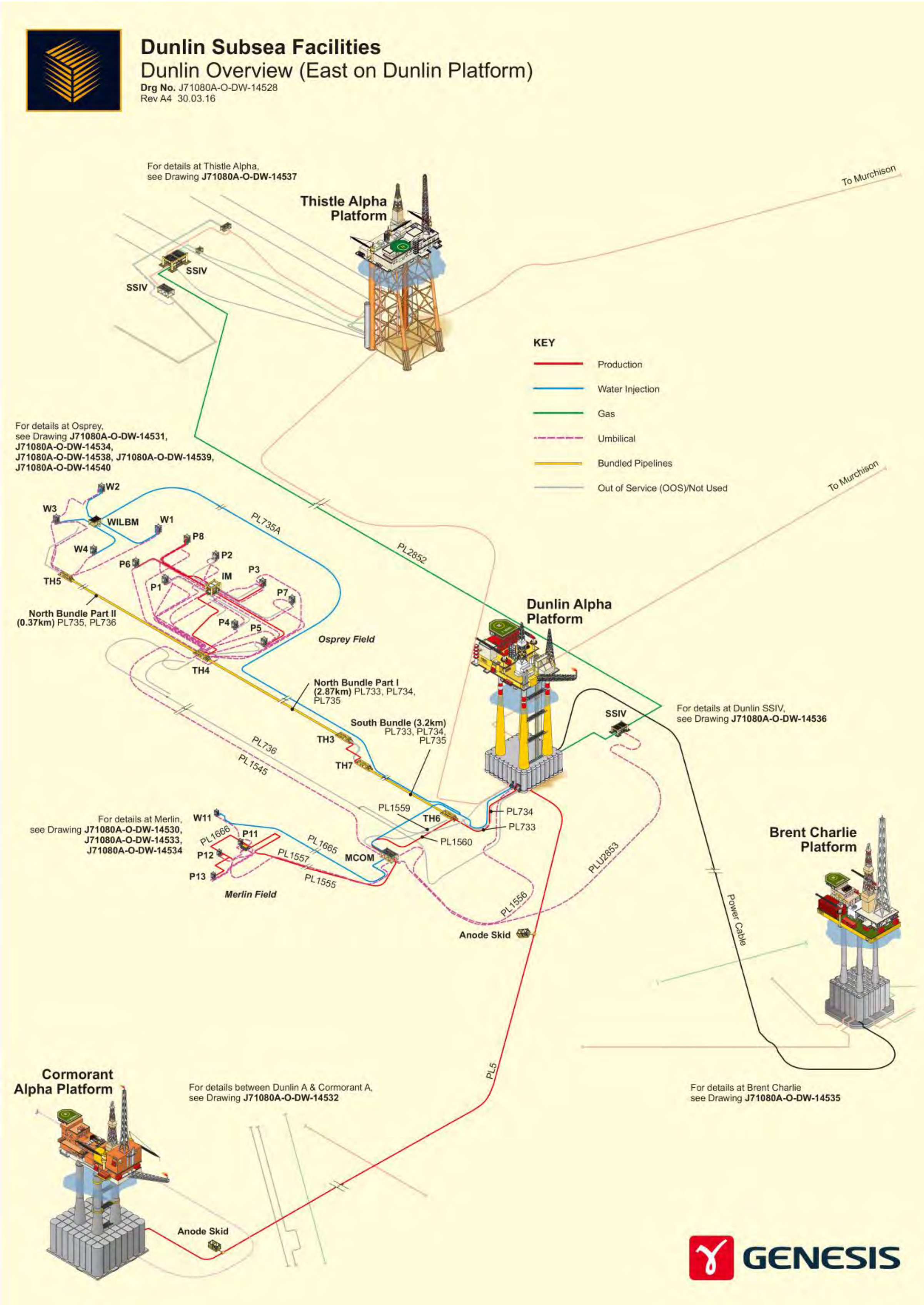


Figure 1.2 Dunlin Alpha Installation in the Context of the Wider Area

1.2. The Dunlin Alpha Decommissioning Project

The Dunlin Alpha installation is a four-leg installation, constructed on a concrete gravity base substructure (CGBS), with a steel box girder-based topsides supporting two levels of modules. The structures visible above the sea surface in its current offshore location are shown in Figure 1.3.

Figure 1.3 Dunlin Alpha Installation

Design and construction of the Dunlin Alpha CGBS on which the topsides facilities sit was carried out by the Anglo Dutch Offshore Concrete (ANDOC) contractors' consortium in the Netherlands during the 1970s. The Dunlin Alpha installation was installed in 1977 and, after the drilling of initial wells, oil production began in 1978. Figure 1.4 shows the CGBS base and concrete legs prior to deployment in the 1970s. A schematic of the Dunlin Alpha installation as a whole is shown in Figure 1.5.

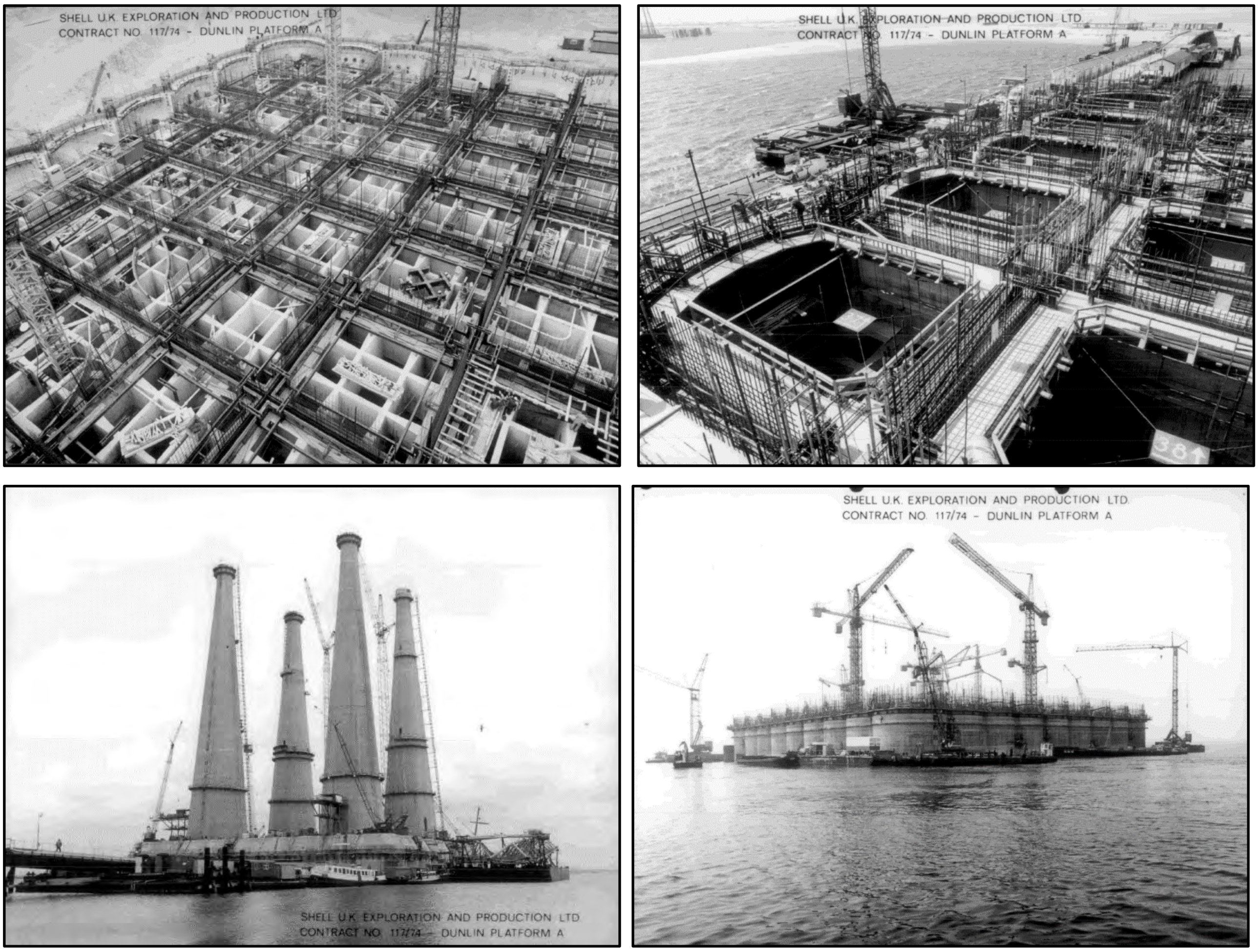


Figure 1.4 CGBS Base and Concrete Legs Shown Prior to Deployment

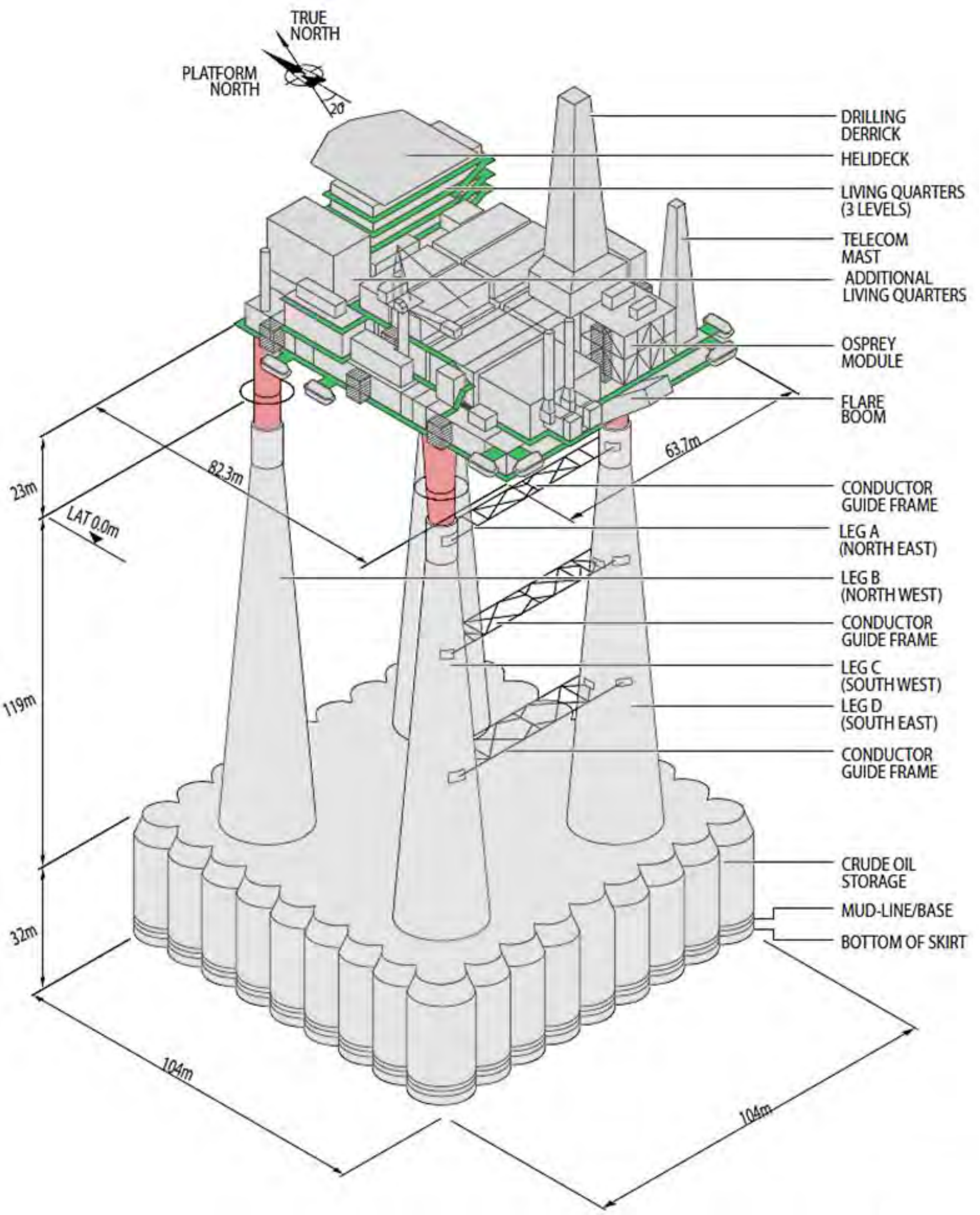


Figure 1.5 Schematic of the Dunlin Alpha Installation

1.3. Regulatory Context

1.3.1. Decommissioning Overview

The decommissioning of offshore oil and gas installations and pipelines on the UKCS is controlled through the Petroleum Act 1998 (as amended[1]). Decommissioning is also regulated under the Marine and Coastal Act

[1] The most recent amendment to the Petroleum Act 1998 was by the Energy Act 2016 which, amongst others, requires relevant persons to consult the UK Oil and Gas Authority (OGA) before submitting an abandonment programme to the Secretary of State, and to require the Secretary of State to consider representations from the OGA when deciding whether to approve a programme.

2009 and Marine (Scotland) Act 2010. The UK's international obligations on decommissioning are primarily governed by the 1992 Convention for the Protection of the Marine Environment of the North East Atlantic (the Oslo Paris (OSPAR) Convention). The responsibility for ensuring compliance with the Petroleum Act 1998 rests with Department of Business, Energy and Industrial Strategy (BEIS), formerly the Department for Energy and Climate Change (DECC). BEIS is also the Competent Authority on decommissioning in the UK for OSPAR purposes and under the Marine Acts.

The Petroleum Act 1998 (as amended) governs the decommissioning of offshore oil and gas infrastructure, including pipelines, on the UKCS. The Act requires the operator of an offshore installation or pipeline to submit a draft Decommissioning Programme for statutory and public consultation, and to obtain approval of the Decommissioning Programme from the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED), part of BEIS, before initiating decommissioning work. The Decommissioning Programme must outline in detail the infrastructure being decommissioned and the method by which the decommissioning will take place.

Formal environmental impact assessment (EIA) to support the Decommissioning Programme is not explicitly required under existing UK legislation. However, the primary guidance for offshore decommissioning from the regulator BEIS, which is nearing publication but which has been circulated to the industry in draft form (BEIS, 2018), details the need for an Environmental Appraisal to be submitted in support of the Decommissioning Programme. The guidance notes set out a new framework for the required environmental inputs and deliverables throughout the approval process. It recognises that environmental deliverables (typically called “Environmental Statements” in the oil and gas industry) to support Decommissioning Programmes have historically been overly lengthy and did not focus in on the key issues, and it now describes a more proportionate Environmental Appraisal process that culminates in a streamlined Environmental Appraisal report rather than a lengthy Environmental Statement. The BEIS guidance is supported by Decom North Sea’s (2017) Environmental Appraisal Guidelines for Offshore Oil and Gas Decommissioning, which provide further definition on the requirements of the Environmental Appraisal report.

In terms of activities in the northern North Sea, the National Marine Plan has been adopted by the Scottish Government to help ensure sustainable development of the marine area. This Plan has been developed in line with UK, European Union (EU) and OSPAR legislation, directives and guidance. With regards to decommissioning the Plan states that ‘where re-use of oil and gas infrastructure is not practicable, either as part of oil and gas activity or by other sectors such as carbon capture and storage, decommissioning must take place in line with standard practice, and as allowed by international obligations. Re-use or removal of decommissioned assets from the seabed will be fully supported where practicable and adhering to relevant regulatory process.’ As part of the conclusions to this assessment (Section 6), Fairfield has given due consideration to the National Marine Plan during Project decision making and the interactions between the Project and Plan.

1.3.2. OSPAR Decision 98/3

As a Contracting Party of the Convention for the Protection of the Marine Environment of the North-East Atlantic, the UK is required to implement OSPAR Decision 98/3, which prohibits leaving offshore installations wholly or partly in place. The legal requirement for operators to comply with the OSPAR Convention is affected through the Petroleum Act 1998 (as amended), as detailed in the Guidance Notes (BEIS, 2018) which outline the expectations of the UK regulator in terms of complying with the relevant OSPAR decisions.

OSPAR Decision 98/3 states that the topsides of all installations should be returned to shore and that all jackets with a weight of less than 10,000 tonnes are completely removed for reuse, recycling or final disposal on land. The Decision recognises that there may be difficulty in removing concrete installations and the 'footings' of large steel jackets that weigh more than 10,000 tonnes. Where the operator recognises that this applies to one of their assets and wishes to consider the possibility of derogation from full removal, the decommissioning guidelines (BEIS, 2018) state that justification on a number of grounds (including environmental, safety, technical, societal and economic) would be required. This process is termed ‘Comparative Assessment’, and is the process by which operators can, with input from the Regulator and other stakeholders, make decisions on the most appropriate approach to decommissioning.

The facility for derogation from the main prohibition for removal of installations applies to the Dunlin Alpha installation as it is a concrete gravity based substructure, as discussed in Section 2. Given the potential for derogation associated with the Dunlin Alpha installation, Comparative Assessment has been a core part of the overall decommissioning planning process being undertaken by Fairfield. Guidelines for Comparative Assessment were prepared in 2015 by Oil and Gas UK (OGUK, 2015a) where seven steps to the Comparative Assessment process were recommended. Fairfield has followed these steps, with full details of the Comparative Assessment process provided in the Dunlin Alpha Comparative Assessment Report (Fairfield, 2018a).

1.3.3. OSPAR Recommendation 2006/5

OSPAR Recommendation 2006/5 governs the Management Regime for Offshore Cuttings Piles. This established a two-stage management regime; Stage 1 provided for initial screening of all cuttings piles, to identify any piles that require further investigation based on the thresholds set out in the Recommendation. Industry’s subsequent report assessing UK cuttings piles in line with the Recommendation concluded that they were all below the specified thresholds. There is no need for immediate remediation of UK drill cuttings, however, at the time of decommissioning the associated installations, the characteristics of the relevant cuttings piles should be assessed in detail and the need for further action (in line with Stage 2 of the Recommendation) should be reviewed. Where either threshold in Recommendation 2006/5 is exceeded, Stage 2 will apply and will require a study, including a comparative assessment, to determine the best option for handling the cuttings pile.

The associated guidance (OSPAR, 2009a) describes two thresholds against which cuttings piles can be compared; persistence to be below the 500 km^2year threshold and oil loss to be below the 10 tonnes per year threshold. The cuttings pile at the Dunlin Alpha installation has been assessed and found not to exceed the OSPAR 2006/5 thresholds, as discussed in Section 0.

1.3.4. Consents to Locate

In addition, BEIS has advised the oil and gas industry that any applications related to decommissioning made under the Marine and Coastal Act 2009 and Marine (Scotland) Act 2010 need to be supported by an EIA. Although such applications are not being made by Fairfield at this time (they may be required later in the decommissioning process), Fairfield proposes to use the information presented herein to support such applications when they are eventually required (this may include Consent to Locate).

1.4. Environmental Management

Relevant to the Environmental Appraisal, and to all of Fairfield's activities, is the company's commitment to managing all environmental impacts associated with its activities. Continuous improvement in environmental performance is sought through effective project planning and implementation, emissions reduction, waste minimisation, waste management, noise reduction and energy conservation; this mindset has fed into the development of the mitigation measures developed for the Project (and detailed in Section 5); these include both industry standard and project-specific measures. A summary of Fairfield's Environmental Management Policy is presented in Figure 1.6.

1.5. Scope and Structure of this Environmental Appraisal Report

This Environmental Appraisal report sets out to describe, in a proportionate manner, the potential environmental impacts of the proposed activities associated with decommissioning of the Dunlin Alpha installation and to demonstrate the extent to which these can be mitigated and controlled to an acceptable level. This is achieved in the following sections, which cover:

- The process by which Fairfield has arrived at the selected decommissioning strategy (Section 2);
- A description of the proposed decommissioning activities (Section 2);
- A review of the potential impacts from the proposed decommissioning activities and justification for the assessments that support this Environmental Appraisal (Section 3);
- A summary of the baseline sensitivities relevant to the assessments that support this Environmental Appraisal (Section 4);
- Assessment of key issues (Section 5); and
- Conclusions (Section 6).

This Environmental Appraisal report has been prepared in line with Fairfield's environmental assessment requirements and has given due consideration to the regulatory guidelines (BEIS, 2018) and to Decom North Sea's Environmental Appraisal Guidelines for Offshore Oil and Gas Decommissioning (Decom North Sea, 2017).

It is the policy of Fairfield Energy Limited (FEL) to seek to conduct its business in a responsible manner that prevents pollution and promotes the preservation of the environment. FEL appreciates that our activities can interact with the natural environment in many ways. We recognise that sustained development of FEL and our long term success depends upon achieving high standards of environmental performance. We are therefore committed to conducting our undertakings in an environmentally responsible manner.

This means that we will:

- Integrate environmental considerations within our business and ensure that we treat these considerations with at least equal importance to those of productivity and profitability;

- Incorporate environmental risk assessment in our business management processes, and seek opportunities to reduce the environmental impact of our activities;

- Continually improve our environmental management performance;

- Comply with all environmental laws, regulations and standards applicable to our undertakings;

- Allocate necessary resources to implement this policy; and

- Communicate openly in matters of the environment with government authorities, industry partners and through public statements.

In particular, we will:

- Maintain an environmental management system in accordance with international best practice and with the BS-EN-ISO 14001:2015 standard, including arrangements for the regular review and audit of our environmental performance;

- Conduct environmental analyses and risk assessments in our areas of operation, in order to ensure that we understand the potential environmental impacts of our activities and that we identify the necessary means for addressing those impacts;

- Manage our emissions according to the principles of Best Available Techniques;

- Publish an annual statement on our public web site, providing a description of our environmental goals and performance; and

- Maintain incident and emergency systems in order to provide assessment, response and control of environmental impacts.

Ultimate responsibility for the effective environmental management of our activities rests with the Managing Director and the Board.

This policy shall be implemented by line management through the development and implementation of working practices and procedures that assign clear responsibilities for specific environmental activities with our employees and contractors. In addition, each of our employees has a personal responsibility to conduct themselves in a manner that enables us to implement this policy and our environmental management system.

FEL has a structured Environmental Management System (EMS), which is certified to the ISO 14001:2015 standard and which establishes the company standards for environmental risk management in accordance with the environmental policy. The EMS is an integral part of the overall business management system and provides a structured and systematic framework for implementing our environmental policy as well as outlining the mechanisms through which compliance is maintained.

The system:

- Applies to all activities under the direct control of FEL throughout the entire life-cycle of managing oil and gas facilities within the UKCS, from exploration to production and eventual decommissioning;

- Applies to all levels within the FEL organisation, including subsidiary companies;

- Applies to all personnel – whether directly employed or contracted (when engaged in activities under FEL's direct control); and

- Provides a basis for establishing suitable interface arrangements with activities performed under contractual arrangement with FEL.

John Wiseman, Managing Director

Figure 1.6 Environmental Management Policy

2. Project Description

2.1. Description of Facilities to be Decommissioned

Note: This section summarises the infrastructure that is subject of the Environmental Appraisal; further details of all infrastructure, including tabulated items and weights, is available in the Dunlin Alpha Decommissioning Programme (Fairfield, 2018b).

2.1.1. Overview of the Dunlin Alpha Installation

The Dunlin Alpha installation, located in 151 m of water, consists of a four-legged concrete gravity based substructure, with modular topsides supported by a steel box girder frame, as shown in Figure 2.1.

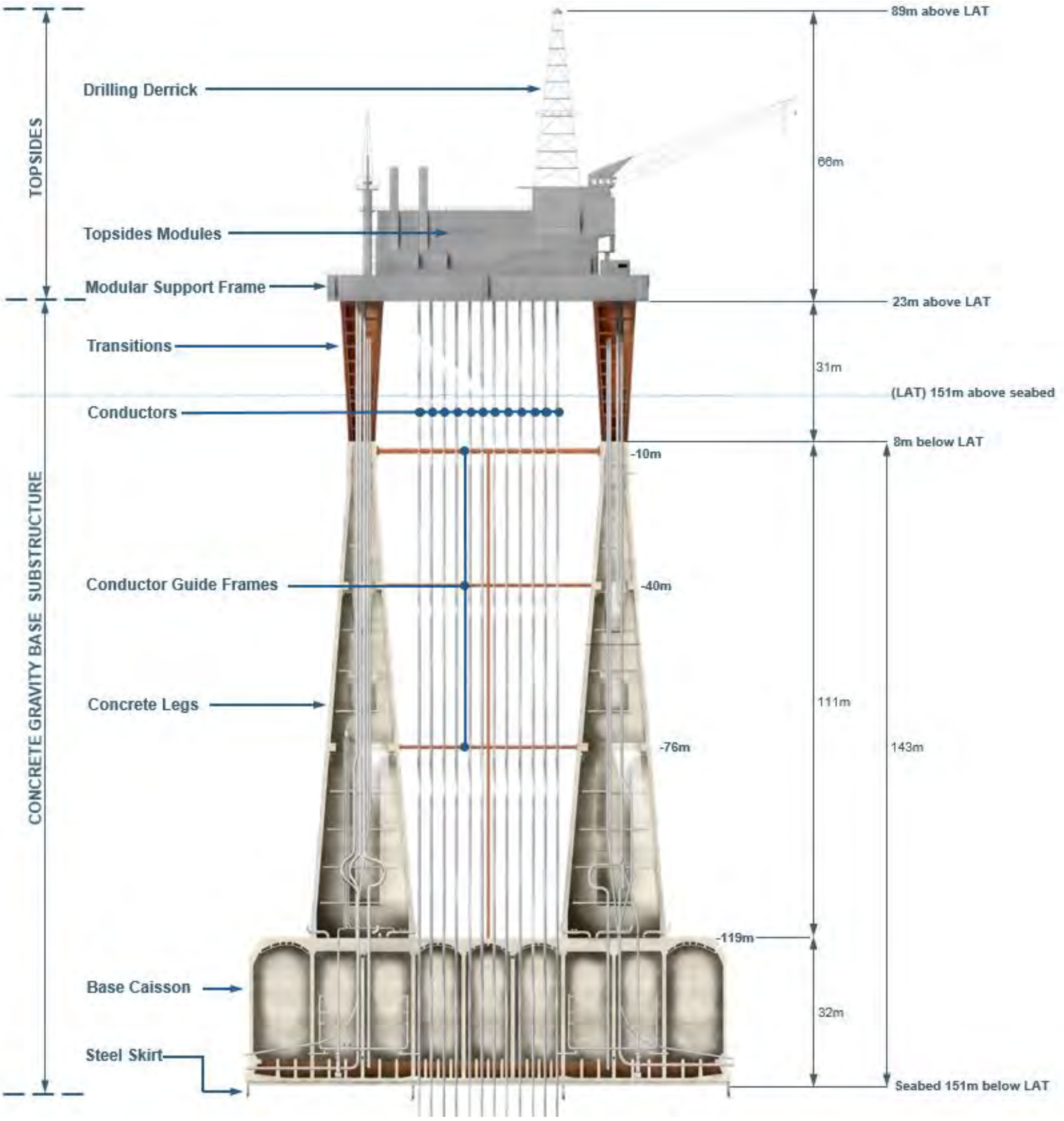


Figure 2.1 Dunlin Alpha installation

The installation was designed to:

- Serve as a production facility for the Dunlin and Dunlin South-West fields, and subsequently for additional production from the Osprey and Merlin fields;
- Serve as a drilling facility for the Dunlin fields;
- Provide separation of oil and water within the CGBS. Continuous use of the storage cells for separation ceased in mid-1995; and
- Accept oil imported from the Thistle Alpha and Murchison platforms, prior to onward export to the Cormorant Alpha platform via pipeline.

The installation base is 104 m square and the installation is over 200 m high from the seabed to the top of the drilling derrick (the highest point shown on Figure 2.1). The installation was designed to accommodate 48 wells, with fluids from the wells passing from the reservoir to the topsides within steel pipes, one per well, the top section of which are known as conductors. The conductors are contained within three steel guide frames located between Legs C and D (leg labels are shown on Figure 1.5 and Figure 2.3).

2.1.2. Topsides

The topsides comprise all the facilities that sit above the surface of the sea. These facilities are contained within three main decks: drilling deck, module deck and lower deck (also referred to as the module support frame, or MSF) and include the following facilities:

- Drilling;
- Oil and gas processing and metering;
- Produced water treatment and water reinjection;
- Power generation, utility and safety systems including flare boom;
- Oil export pumping;
- Personnel accommodation for up to 140 people;
- Helicopter deck (helideck); and
- Two pedestal cranes.

Figure 2.2 shows an isometric diagram of the Dunlin Alpha installation.

The total (dry) weight of the topsides is approximately 19,640 tonnes.

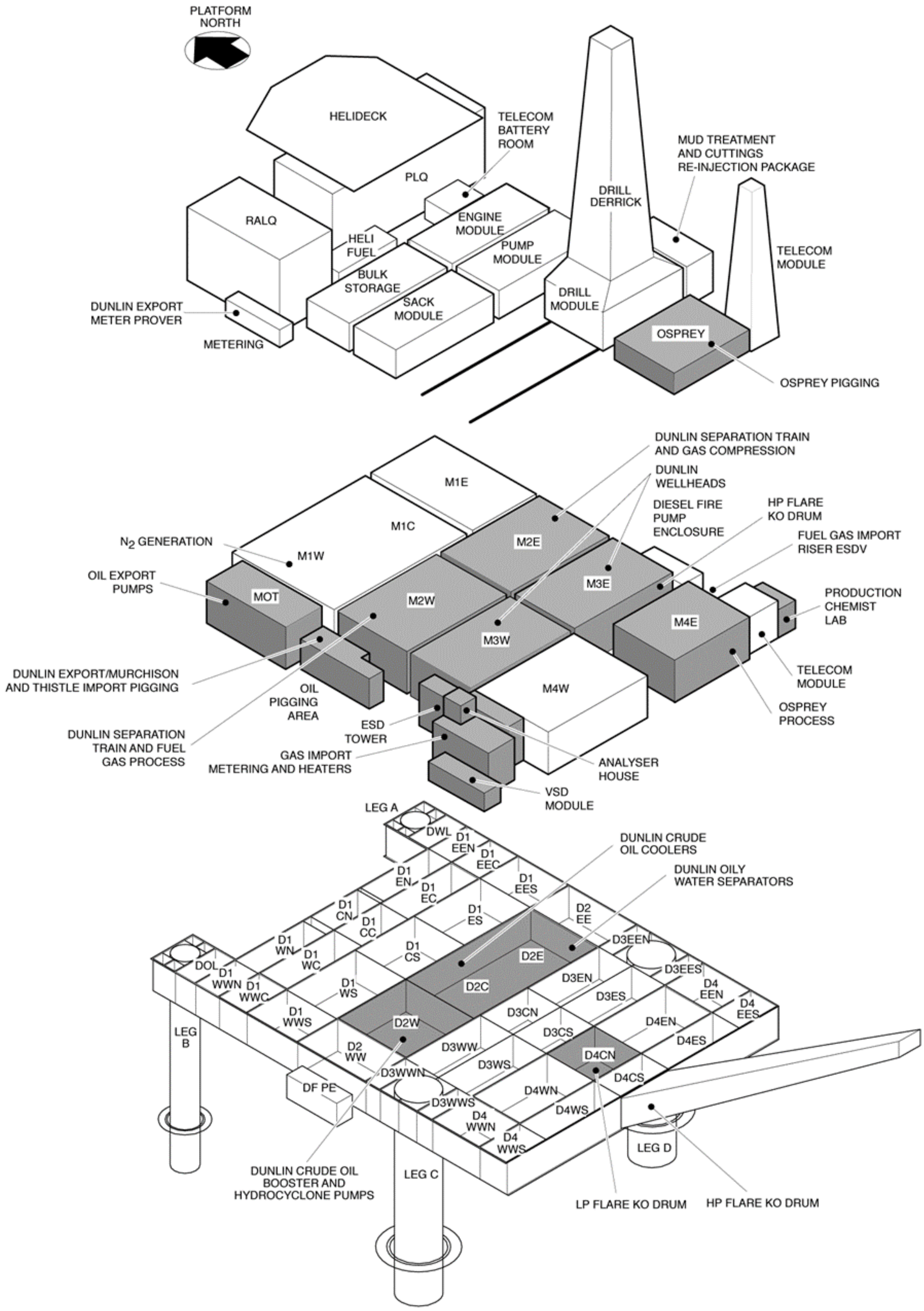


Figure 2.2 Isometric Description of the Dunlin Alpha Installation

2.1.3. Concrete Gravity Base Substructure (CGBS)

The CGBS extends from the seabed to the tops of the steel transitions, as shown in Figure 2.3.

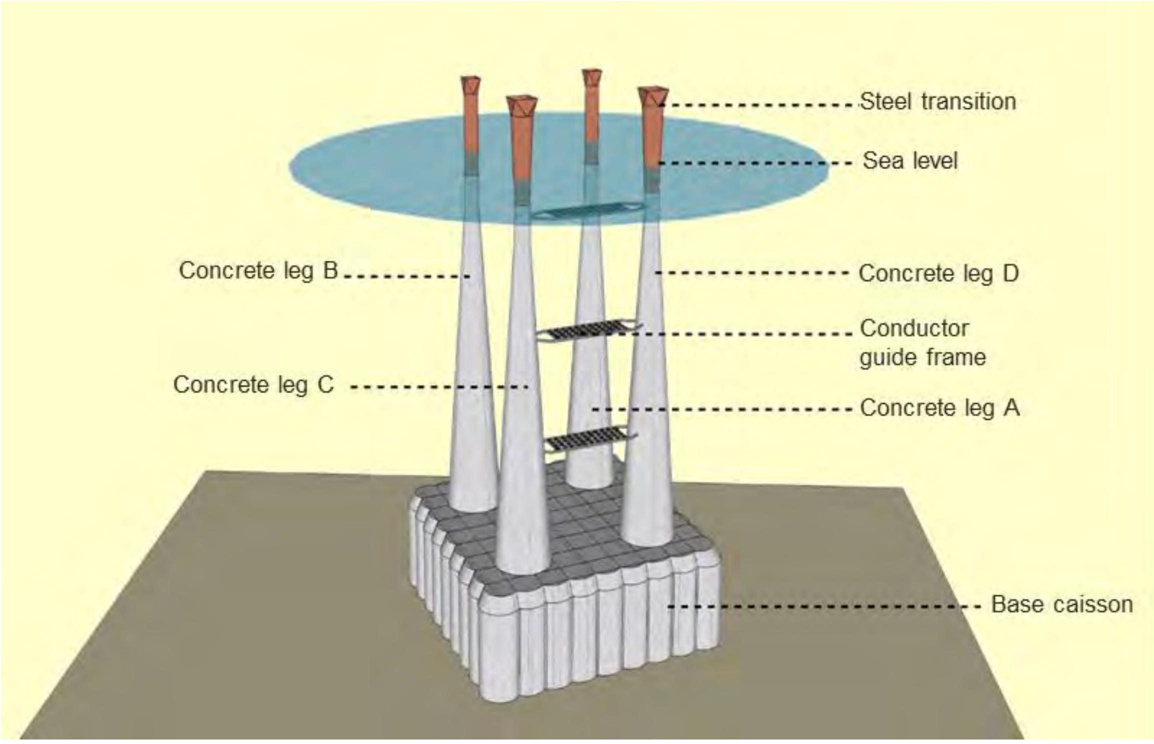


Figure 2.3 CGBS Base and Concrete Legs (topsides and conductors not shown)

The Dunlin Alpha CGBS weighs approximately 336,000 tonnes, comprising 236,500 tonnes of steel reinforced concrete with the remainder of the weight being attributable to internal equipment in the legs, solid granular iron ore ballast in the base of the CGBS, and steel seabed skirt. The CGBS was not designed to be re-floated.

Rising up from the roof of the base cells are four concrete legs, each 111 m high. These reduce in outside diameter from 22.65 m at the bottom to 6.7 m at the top, where they join the steel superstructure at 8 m below sea level. The legs are designed as hollow shafts, with concrete walls generally being 700 mm thick but increasing to 1,200 mm at the top and the bottom. Each of the concrete legs weighs approximately 8,625 tonnes. The bolted connections are grouted in place.

Equipment and pipework are distributed within the legs, in order to provide a range of different functions:

- Leg A contains pumps associated with storage water, service water, firewater and conductor cooling water systems;
- Leg B contains oil export pipework and pump;
- Leg C contains the import risers (pipelines which run from the seabed to the topsides) bringing in oil from Thistle and Murchison fields and the export riser to send the same oil on to Cormorant Alpha and the Sullom Voe terminal on Shetland; and
- Leg D contains spare riser facilities.

The top part of the CGBS is made up of four transitions constructed from stiffened steel plate, which rise above the sea surface to the underside of the topsides (where they meet the MSF). The steel transitions are bolted and grouted into the top of the concrete legs. The transitions on Legs C and D weigh approximately 500 tonnes each and change in cross section from approximately 6 m circular shape diameter at the top of the concrete legs to approximately 8.7 m square at the underside of the MSF. The other two steel transitions (on Legs A and B) weigh approximately 295 tonnes each and are 5.4 m circular shape diameter changing to a 5.4 m square section at the deck underside. This is represented graphically in Figure 2.4.

The Leg A and Leg B transitions are connected to the concrete legs with one external row of 40 bolts, plus two internal rows of 40 bolts of the same size (120 bolts in total per leg). The Leg C and Leg D transitions are connected to the concrete towers with two external and two internal rows of bolts totalling 160 bolts per leg.

Spanning between Legs C and D are three horizontal steel guide frames which contain the well conductors in a 12 x 4 matrix. The function of these frames is to provide horizontal support to the 48 well conductors against wave action forces. Each of the three frames weighs approximately 200 tonnes.

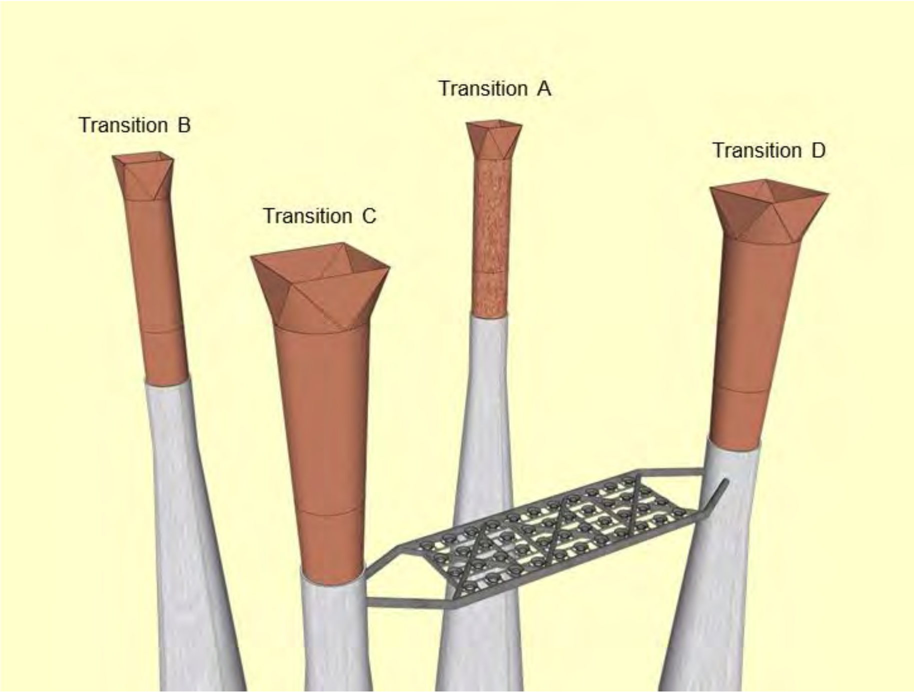


Figure 2.4 Transitions at the Tops of the Concrete Legs (topsides and conductors not shown)

The CGBS base caisson, which is 32 m high, is divided into 81 compartments, referred to as cells, arranged in a 9 x 9 matrix as shown in Figure 2.5. Each cell is 11 m square. Inside the bottom of each cell, secondary 4 m high concrete walls reinforce the base and sub-divide the bottom of each cell into nine open-topped compartments (Figure 2.5). These sub-compartments are filled with granular iron ore to act as ballast and are sealed with convex concrete roofs.

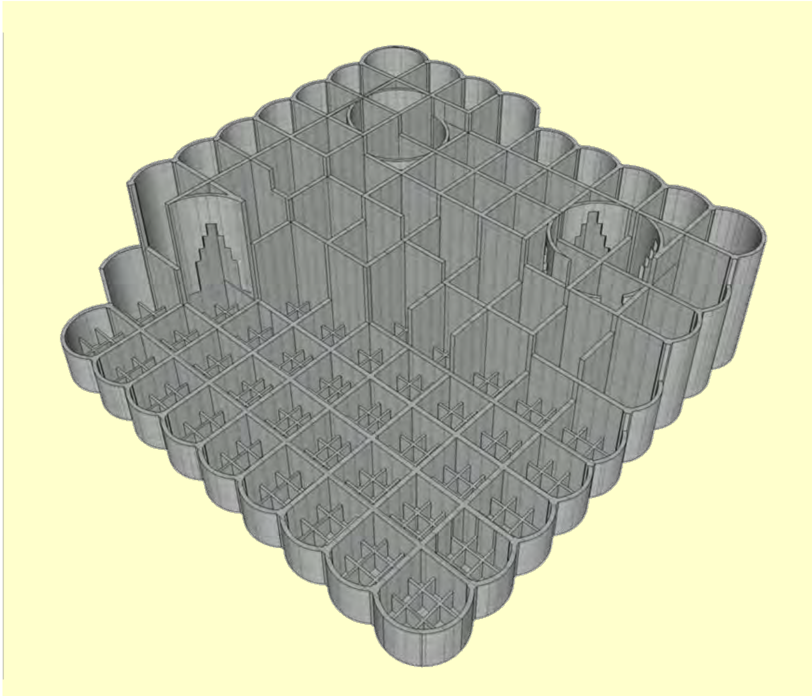


Figure 2.5 Cells in the CGBS (cutaway view)

Figure 2.6 shows formwork within the internal structure of the cell tops that was used to support the construction of the concrete domed roofs. The formwork is a six-by-six lattice structure that effectively creates thirty-six further sub-compartments in the top of each individual domed roof.

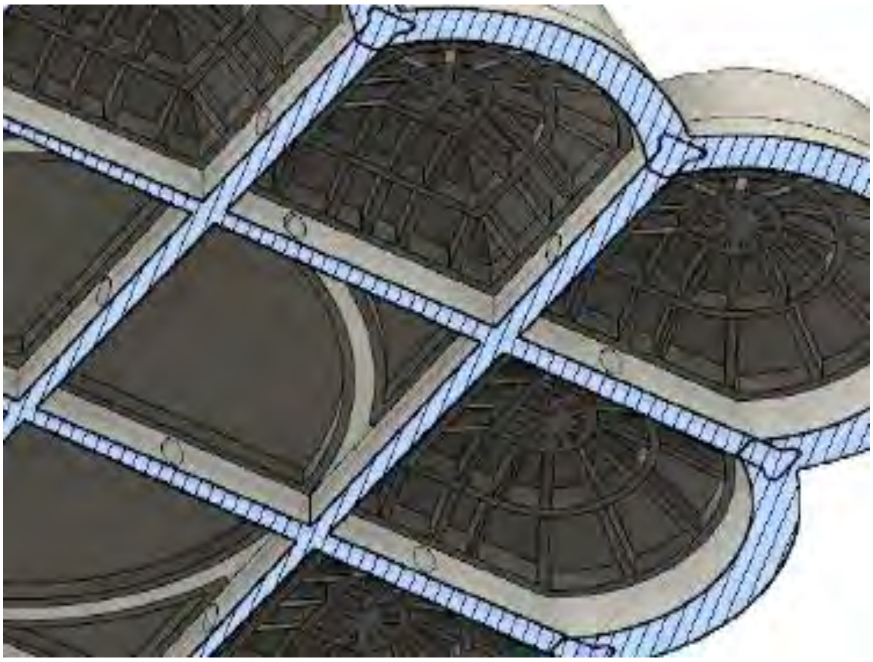


Figure 2.6 Formwork Within the Cell Tops

A stiffened steel plate wall runs around the outside perimeter of the base caisson to form a skirt, and penetrates the seabed to a depth of 4 m. Two further steel walls run underneath the base slab of the CGBS in each direction, creating nine sub-base compartments.

Of the 81 cells, the original purpose of 75 of these was to provide additional separation of oil and water prior to oil export; this meant that fluids from the reservoir were pumped into the cells to allow the water and hydrocarbons to separate so that the hydrocarbons could be transported on for sale. The remaining six cells, located between Legs C and D, were not used for oil and water separation and are filled with seawater. The 48 well conductors pass through these six cells, each conductor being protected by an outer carbon steel sleeve throughout the height of the cells. The six cells were designed to allow seawater to be pumped around the conductors to keep them cool.

2.1.4. Cells Contents

2.1.4.1. Overview

The majority of material present in the cells (excluding seawater) will have originated from the reservoir, brought in as components of the produced fluids. These components include hydrocarbons (oil and wax), inert particulate material (sand and clay) and scale (inorganic, sparingly soluble salts arising from aqueous brines from hydrocarbon production). The particulate material (sand and clay) is settled at the base of the cells, while the scale and hydrocarbons, introduced via the fluid phases of the produced hydrocarbons, have deposited on the cell walls, roof and floors through physical and chemical processes. Other materials associated with these main component groups, particularly with the hydrocarbons and scale, include organic and inorganic compounds, metals and naturally occurring radioactive material (NORM). Residual mobile oil is present at the top of each cell, floating on the water that makes up the main component of the cell contents. Figure 2.7 details the cell structure and various contents.

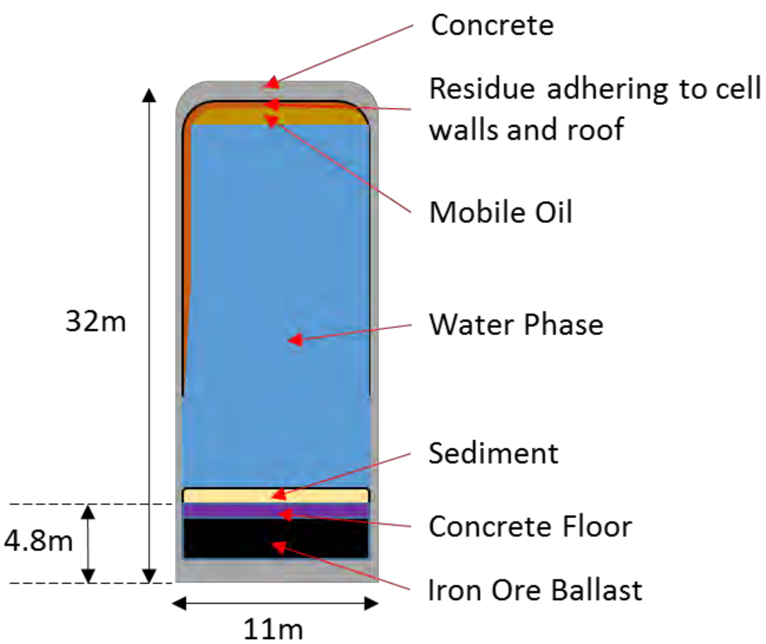


Figure 2.7 Overview Schematic of a Cell Including Representation (not to scale)

A Cell Contents Technical Report (CCTR) has been developed in support of the Dunlin Alpha Decommissioning Project. The CCTR provides an extensive review of the cell contents in order to quantify and characterise the residual materials present in the CGBS cells. The information used is based on evidence gathered from operational records, analysis of historical samples, analogous data, and / or the application of proven scientific principles. Uncertainties associated with the base data have been assessed and where appropriate, conservative (worst-case) assessments have been applied.

The following sections provide a summary of the cell contents characteristics as described in the CCTR (Fairfield, 2018c).

2.1.4.2. Oil

In 2007, Shell (the previous owner of the Dunlin Alpha installation) executed a project to recover the mobile oil remaining in the cells since their use stopped in 2004. This project was called the Attic Oil Recovery Project. The pipework in the cells that originally took oil away out of the cells is positioned below the top of the ceiling of the cells. As the oil floats on the water in the cells, there was an inaccessible volume of oil above the pipework which could not be extracted by the existing platform pumps during the Attic Oil Recovery Project (the term "attic oil" is used to describe the oil sitting in the upper sections of the cell compartments). The project was able to use Carbon Dioxide (CO_2) gas to push the oil down and to make it accessible via the pipework. Pumping was performed by a new set of temporary pumps that were able to draw off the oil. As part of an extensive review of the cell contents undertaken for the Project (Fairfield, 2018c), Fairfield have concluded that the CO_2 displacement technique would have been effective, leaving only a thin layer of residual oil in the top of the attic space of each cell.

Table 2.1 shows the oil composition used as a basis for the calculations used in the Fairfield CCTR (Fairfield, 2018c).

Table 2.1 Oil Composition

Component	**Concentration %**
	Best estimate
-------- Overall Fractions --------	
<C12	29
C13 to C19	23
>C20	48
-------- Benzene, Toluene, Ethylbenzene and Xylene (BTEX) Compounds --------	
Benzene	0.092
Toluene	0.38
Ethylbenzene	0.31
Xylenes (o,p,m)	0.69
Total BTEX	**1.5**

Component	Concentration %
	Best estimate
-------- PAH Compounds --------	
Naphthalene	0.03
Acenapthene	0.036
Pyrene	0.0075
Phenanthrene	0.0053
Fluorene	0.0028
Fluoranthene	0.0018
Anthracene	0.00045
Chrysene	0.00025
Total PAH	**0.08**

2.1.4.3. Water

The storage cells are completely liquid filled, the spaces not occupied by oil, the ceiling and wall residues and the sediment built-up on the cell floor are filled with water.

Dissolved contaminants will be present in the water phase as a result of:

- Chemical reactions within the cells altering major components of the water phase.
- Chemical reactions within the cells causing precipitated materials to go into solution.
- Unaltered components in the residual material dissolving into the water.
- Water soluble chemicals being introduced during installation operations from the processing system including those introduced to the drainage system.
- Chemicals added during the AORP.

Table 2.2 details the expected composition within the water.

Table 2.2 Water Composition

Component	Concentration (g/m^3)	Quantity in solution (tonnes)
-------- Metals --------		
Arsenic (As)	0.02	0.004673
Cadmium (Cd)	0.006	0.001402
Chromium (Cr)	0.01	0.002336

Component	Concentration (g/m³)	Quantity in solution (tonnes)
Copper (Cu)	0.016	0.003738
Lead (Pb)	0.000125	0.000029
Mercury (Hg)	0.0001	0.000023
Nickel (Ni)	0.01	0002336
Zinc (Zn)	0.0032	0.000747
Total Metals	**0.065425**	**0.015285**
-------- BTEX --------		
Benzene	1.79	0.418200
Toluene	0.54	0.126161
Ethylbenzene	0.15	0.035045
Xylenes (o,p,m)	0.20	0.046726
Total BTEX	**2.68**	**0.626131**
Total Hydrocarbon Content (THC)	**40**	**9.3**

2.1.4.4. Chemicals

Chemicals introduced into the wells and topsides processing systems which partition with the water phase may be present within the storage cells. The chemicals which would have passed into the storage cells on a regular basis were:

- Demulsifier and anti-scale chemicals injected into the production stream; and
- Oxygen scavenger and anti-scale chemicals injected into the water injection system.

Biocides were also in use, but only on an occasional batch dosage basis; these quantities would have been insignificant compared to the overall throughput. Similarly, scale squeeze treatments may have been applied to treat scale in the wells upon seawater breakthrough, but the volumes of chemicals utilised would have been small in comparison to the volumetric throughput of the production system.

Based on the volume of water within the cells, this equates to a total quantity of around 214 kg of chemicals within the CGBS base caisson.

Nonylphenol and nonylphenol ethoxylates (NP/NPE) compounds are not anticipated to be present within the storage cells in significant quantities (Fairfield, 2018c). The offshore use of NP and NPE containing products, mainly associated with production demulsifiers and asphaltene controlling agents, ended in 1999. While only demulsifier chemicals were used in the Dunlin Alpha process and at low dosage rates in the region of 40 mg/kg maximum a small quantity of NP and NPE may nevertheless have accumulated with the water in the sediments in the floor of the cells.

2.1.4.5. Sediment

The sediment phase is considered to be made up of the following materials:

- Sand and clays;
- Hydrocarbons in the form of oils and waxes;
- Small quantities of naturally occurring contaminants such as heavy metals and low specific activity (LSA) scale or NORM; and
- Water
    - The water could contain fluids from the topsides drain system such as lubricating oils, solvents/cleaning compounds and cooling fluids, etc.
    - Residual quantities of production chemicals may be present.

The amount of heavy metals present in the sediment has been determined by using the anticipated concentrations in the constituents of the sediment phase, i.e. hydrocarbon, scale, clay and water (as detailed in Table 2.3). This gives an overall basis for the heavy metal concentrations within the sediment. However, it is recognised that there will be variability depending on the composition ratios of the constituent materials. OSPAR background levels have been included for comparison in Table 2.3.

Table 2.3 Heavy Metals Concentration in the Sediment Phase

Heavy metal	Concentration (mg/kg)	OSPAR Background Concentrations (mg/kg)[2]
Arsenic (As)	2.26	15
Cadmium (Cd)	1.30	0.2
Chromium (Cr)	13.9	60
Copper (Cu)	468	20
Mercury (Hg)	0.101	0.005
Nickel (Ni)	750	30
Lead (Pb)	159	25
Vanadium (V)	71	-
Zinc (Zn)	105	90

[2] OSPAR (2012). CEMP 2011 Assessment Report – Monitoring and Assessment Series.

2.1.4.6. Waxy Residue

The operational cycle of the cells may have led to solid wax forming on the surfaces within the cells as the produced fluids cooled. Fairfield conducted an assessment to determine the residual wax adhering to the walls (Fairfield, 2018c). A deposited volume of 306 m^3 on the cell walls and roof was calculated.

The concentration of heavy metals in the wall residues will be similar to those present in the mobile oil phase and is detailed in Table 2-4.

Table 2.4 Heavy Metals Concentration in the Wall Residue

Heavy Metal	Concentration (mg/kg)
Arsenic (As)	0.0045
Cadmium (Cd)	0.011
Chromium (Cr)	0.0174
Copper (Cu)	0.0609
Mercury (Hg)	0.0055
Nickel (Ni)	1.5
Lead (Pb)	0.0454
Vanadium (V)	2.25
Zinc (Zn)	0.59

2.1.4.7. Summary

Table 2.5 details the expected contents of all cells following the 2007 Attic Oil Recovery Project. Figure 2.8 provides a visual summary of the components.

Table 2.5 Contents of Cells

Phase	Volume (m³)	% the total volume of the cells
Residual attic oil[3]	988	0.42
Trapped oil[4]	449	0.19
Diffused oil[5]	128	0.05
Total mobile oil in all cells	**1,565**	**0.66**
Sand/clay	363	0.15
Scale	159	0.07
Hydrocarbon	363	0.15
Water in sediment	363	0.15
Total sediment (brought up from the reservoir)	**1,248**	**0.53**
Wall residue	**462**	**0.19**
Water	**233,631**	**98.62**

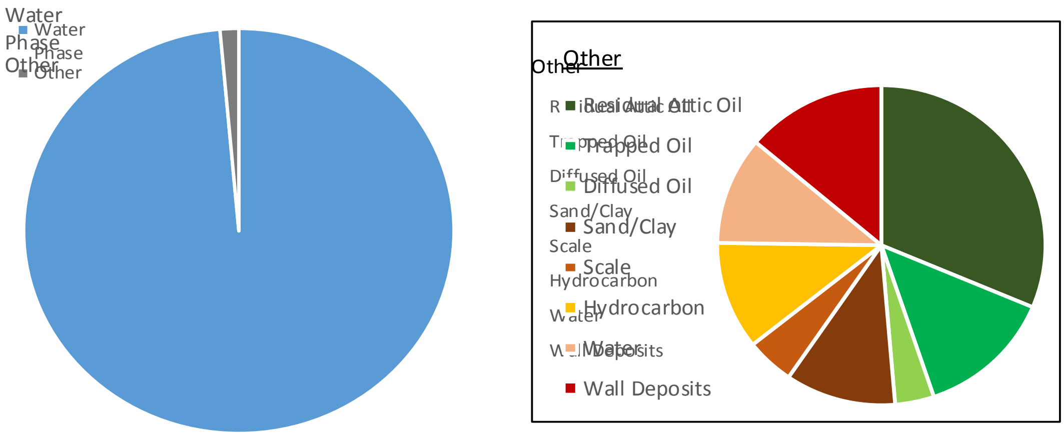


Figure 2.8 Summary of Cell Contents

---

[3] In the top of the cells.
[4] Oil trapped in triangular areas where the cells meet the concrete legs.
[5] Diffused hydrocarbons from the sediment and wall residue, as released over time since completion of the attic oil recovery in 2007.

2.1.5. Drill Cuttings

During drilling, rock is cut into small pieces by the drilling activity and is removed from the well. The rock is usually ejected from the well in a mix with some of the chemicals used to help the drilling activity; a particular set of chemicals are called 'drilling muds', and these are used to help move the rock that is drilled up to the surface. This mix is termed 'drill cuttings'. In total, 733,126 ft (223.45 km) of rock was drilled through from the Dunlin Alpha installation, equating to an estimated 1,063,117 ft^3 (30,086 m^3) of drill cuttings, of which over 99% were discharged. At 48,888 tonnes, the current drill cuttings pile at Dunlin Alpha weighs more than twice the weight of the installation topsides itself.

Up until 2001, the drilled cuttings from the first sections of the wells drilled were returned to the installation where the mud and cuttings were separated, the mud recovered for reconditioning and reuse and the cuttings routed to the cuttings chute. The cuttings chute on the Dunlin Alpha installation was hooked up to an unused conductor which fed through the three guide frames, terminating at 80 m below Lowest Astronomical Tide (LAT). From here, cuttings fell the remaining 38 m to the top of the CGBS base, eventually spilling over the south side of the CGBS base and down to the seabed a further 33 m below. Figure 2.9 shows that the cuttings are located on the south-east part of the CGBS and on the seabed against the south-eastern side of the CGBS. The average depth of cover within the entire Dunlin drill cuttings deposition area is 2.48 m, whilst the maximum thicknesses of the CGBS and seabed cuttings piles are 12.9 m and 12.8 m, respectively.

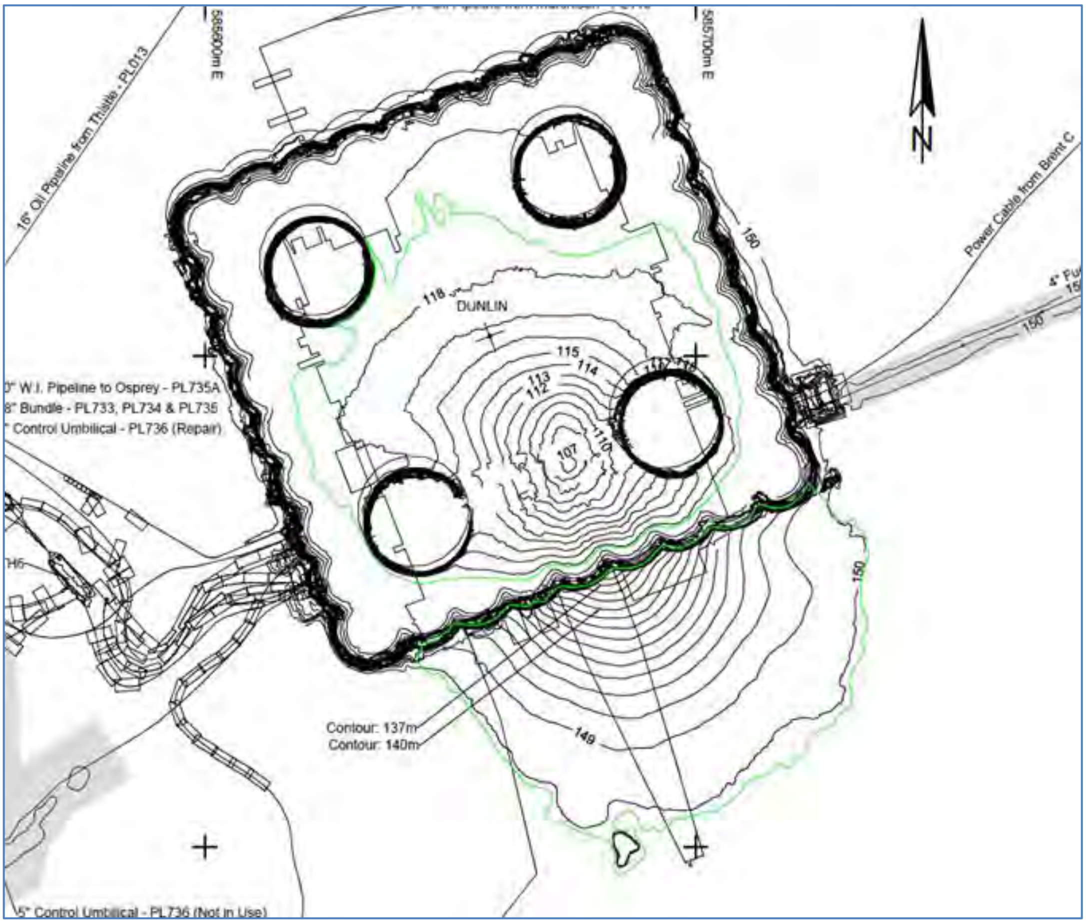


Figure 2.9 Profile of Drill Cuttings Profile at the Dunlin Alpha Installation

In 2001, OSPAR Decision 2000/3 on the Use of Organic-phase Drilling Fluids (OPF) and the Discharge of OPF-contaminated Cuttings prohibiting the discharge of drill cuttings contaminated with more than 1% oil by weight of oil based fluids came into force. Very limited drilling occurred from the Dunlin Alpha installation after the implementation of OSPAR Decision 2000/3 and, in the context of total volume, account for less than 1% of the total volume of cuttings generated from Dunlin Alpha installation well drilling. The majority of cuttings discharged over the life of the Dunlin Alpha installation were therefore associated with drilling using oil-based mud.

An assessment of the oil-based cuttings piles at the Dunlin Alpha installation was undertaken to determine the status of the drill cuttings and to understand the most appropriate course of action for the Dunlin Alpha Decommissioning Project with regards the fate of the cuttings is (e.g. removal, leave *in situ* etc.) (Fugro, 2018). Key to this assessment was consideration of OSPAR Recommendation 2006/5 on management regime for offshore cuttings piles. This guidance describes two thresholds against which cuttings piles can be compared; one relates to the length of time and the size of the area over which the cuttings pile will remain (called persistence) and the other is the rate at which oil comes out of the cuttings pile over time (called leaching). The cuttings pile at the Dunlin Alpha installation has been assessed and does not exceed the OSPAR 2006/5 thresholds regarding the expected persistence and rate of loss of oil; estimates calculated by Fugro (2018), given in Table 2.8, show persistence to be below the 500 km^2year threshold and oil loss to be below the 10 tonnes per year threshold specified by OSPAR (2009a). Further information on these values, and of the potential environmental impact of future potential disturbance of these piles, is given in Section 5.3.

Table 2.6 Estimates of Dunlin Cuttings Piles in the Context of the OSPAR 2006/5 Thresholds

Site	Persistence (km^2 year)	Yearly oil loss (tonnes)
Total area of cuttings	47.4	0.49 – 1.75
OSPAR Threshold	500	10

2.1.6. Summary of Facilities

Table 2.7 provides a summary of the infrastructure and the weight of material associated with the facilities to be decommissioned, as described in the previous sections.

Table 2.7 Approximate Weights of the Dunlin Alpha Installation Infrastructure

Section	Weight (tonnes)
Topsides (Dry Weight)	19,640
Transitions	1,590[6]
Conductors (x 48)	3,840
Conductor Guide Frames (x 3)	540

[6] Structural weights include a 5% contingency.

Section	Weight (tonnes)
Concrete Legs	34,500[5]
Leg Internals	1,250
Base Caisson	202,000 [7]
Iron Ore Ballast	96,800[5]
Seabed Skirt	1,450[5]
Drill Cuttings	48,888
Total	**410,490**

2.2. Consideration of Alternatives and Selected Approach

Note: This section summarises the Comparative Assessment undertaken for the Dunlin Alpha installation; full details of the process and data used to inform decision-making is available in the Dunlin Alpha Comparative Assessment Report (Fairfield, 2018a).

2.2.1. Alternative to Decommissioning

Following cessation of production in June 2015, options to re-use the Dunlin Alpha installation for future hydrocarbon developments have been assessed but, to date, none have yielded a viable commercial opportunity. There are a number of reasons for this, including the absence of remaining hydrocarbon reserves in the vicinity of the Greater Dunlin Area. It is now considered unlikely that any opportunity to reuse the Dunlin Alpha installation will be feasible. As such, there is no reason to delay decommissioning of the Dunlin Alpha installation in a way that is safe and environmentally and socio-economically acceptable.

2.2.2. Options for Decommissioning the Dunlin Alpha Installation

2.2.2.1. Topsides

According to the latest guidance from the Regulator (BEIS, 2018), topsides of offshore installations must be removed. In accordance with this guidance, Fairfield proposes to recover the topsides to shore. Further information on how this will be achieved is provided in Section 2.3.3.1.

2.2.2.2. CGBS

In line with the latest BEIS guidelines on decommissioning (BEIS, 2018), Fairfield undertook a Comparative Assessment in order to arrive at a decision for the decommissioning method. An initial option screening

[7] These figures do not include the weight of materials remaining with the CGBS Base Caisson. See Section 2.1.3 for details.

exercise was performed against available decommissioning options. This exercise, illustrated in Figure 2.10, screened the initial nine options identified down to four which were carried forward to the evaluation phase of the Comparative Assessment. The screening performed is detailed fully in the Dunlin Alpha Decommissioning Option Screening for Comparative Assessment document (Fairfield, 2016).

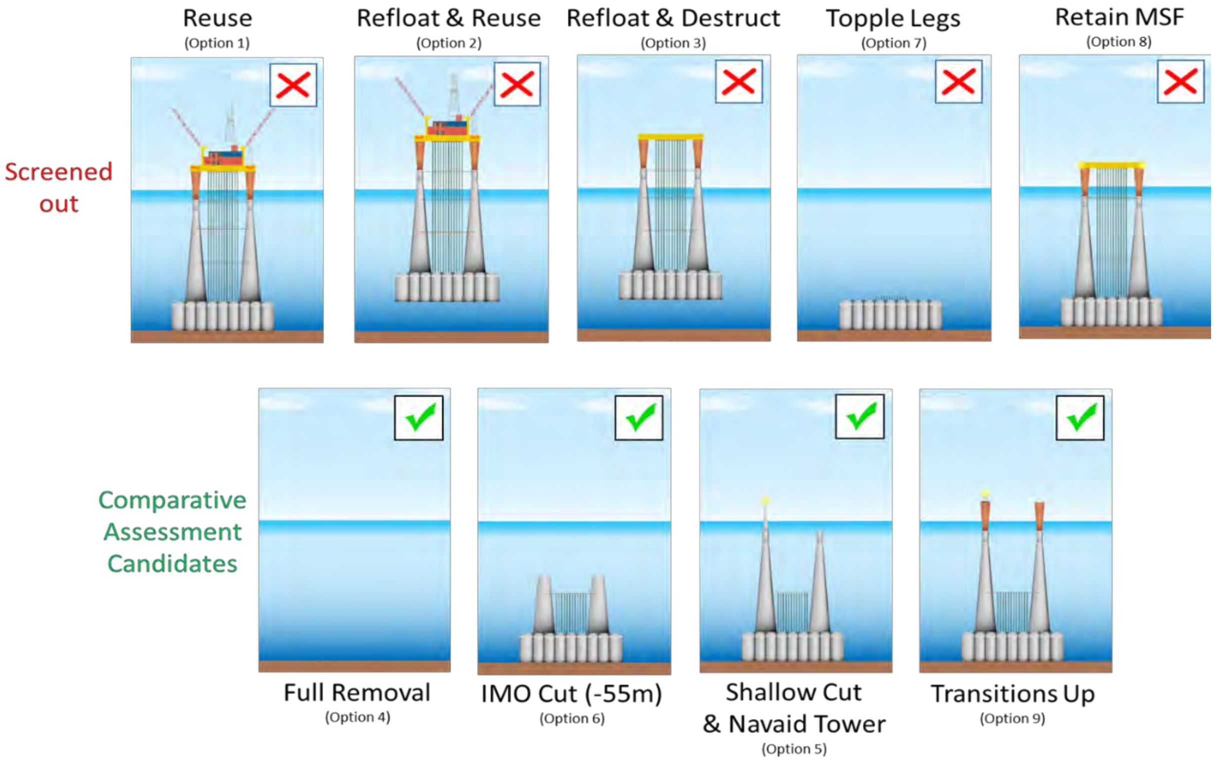


Figure 2.10 Option Screening Summary

The option screening process concluded that there are no valid reuse options for Dunlin Alpha (Option 1). Options to refloat the CGBS (Option 2 and Option 3) were deemed to not be feasible due to integrity issues and substantial technical challenges. The option to 'topple' the concrete legs (Option 7) also has significant technical challenges, and both Option 7 and Option 8 were deemed to be unacceptable by the Regulator.

The remaining four options were taken through to the evaluation phase of the Comparative Assessment, where detailed study work was undertaken. These four options are summarised overleaf.

Option 4 – Full Removal

Option 4 would involve complex in situ deconstruction of the substructure by a single Heavy Lift Vessel (HLV) utilising a Dive Support Vessel (DSV)/barge for cut, lift, transport and recycle/disposal.

The drill cuttings, cell contents, conductors and Conductor Guide Frames would be removed. The base caisson would require piece small deconstruction by ROV on a cell by cell basis and is estimated to take in excess of 40 years to complete.

A navaid would not be required as the concrete would be fully removed.

Option 6 – International Maritime Organisation (IMO) Compliant Cut

Option 6 would involve removing the steel transitions and upper concrete leg sections. Shallow and IMO Compliant cut zones would be cleared and leg internals above these removed.

The subsea cuts would be completed by a single HLV utilising a DSV/barge for cut, lift, transport and recycle/disposal.

A navaid would not be required.

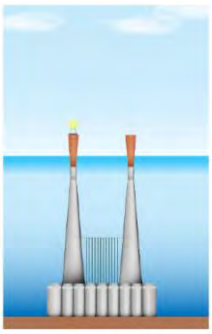
Option 5 – Shallow Cut

Option 5 would involve removing the steel transitions. Shallow cut zone would be cleared and leg internals above this removed.

The subsea cut would be completed by a single HLV utilising a DSV/barge for cut, lift, transport and recycle/disposal.

A prefabricated concrete support tower would be installed subsea on one of the cut concrete legs in order to carry a navaid.

Navaid monitoring and maintenance would be required post-decommissioning.



Option 9 – Transitions Up

Option 9 would involve topside removal only, leaving the four steel transitions in place.

One of the steel transitions would be used to carry a navaid. This would have its internal walls coated and cathodic protection installed.

Navaid monitoring and maintenance would be required post-decommissioning.

To compare each option against the others to arrive at a decision, Fairfield utilised a Multi Criteria Decision Analysis (MCDA) tool. This tool uses pairwise comparisons to consider differences between options - essentially, the assembled team reviews the available data for each option and determines, using terms such as 'neutral', 'stronger', 'much stronger' (and so on), how each option compares to the other. This comparison was undertaken using the five criteria described in the BEIS Guidelines for Decommissioning of Offshore Oil and Gas Installations and Pipelines (BEIS, 2018):

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

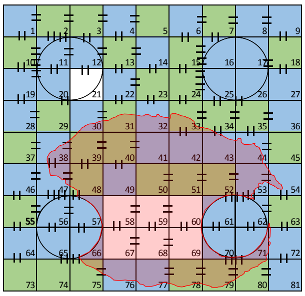
The Comparative Assessment concluded that the option to decommission the Substructure *in situ* with 'Transitions Up' (Option 9) was the most preferred of the derogation options against Safety, Technical, Economic and Environmental criteria. When evaluated against the Full Removal option (Option 4), Option 9 was also the most preferred option when assessed against Safety, Technical, Economic and Environmental criteria (Fairfield, 2018b).

Full Removal of the Substructure was the preferred option in regard to 'legacy marine environmental impacts', as its removal would eliminate potential future impacts. However, it is anticipated that the full removal of the CGBS would involve approximately 40 years of subsea cutting and concrete removal activities, with associated noise, atmospheric emissions and unavoidable marine discharges. As a result, Option 9 was the preferred option when assessed against 'operational marine environmental impacts' and 'atmospheric emissions' sub-criteria. In addition, potential legacy environmental impacts associated with both a gradual release and an unplanned instantaneous release of cell contents were assessed to inform the Comparative Assessment process. For both scenarios, environmental impacts were assessed to be not significant, as described in Section 5.

The recommendation from the CGBS Comparative Assessment is to decommission the substructure *in situ* with 'Transitions Up', install a navigational aid on top of one of the transitions, and apply cathodic protection and coatings to reduce corrosion rates.

2.2.2.3. CGBS Cell Contents

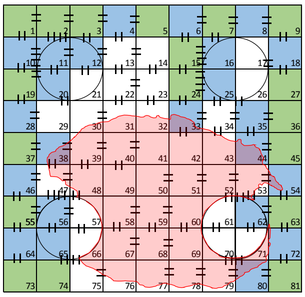
Fairfield conducted an intensive study on the residual cell contents (Fairfield, 2018c) to better understand and characterise the contents of the cells. The study then progressed on using this inventory as the base case to evaluate potential management options and inform the Comparative Assessment of the feasible options for decommissioning. The study demonstrated that full removal of the residual cell contents is only technically feasible should the whole CGBS be removed and in doing so there would be inevitable release of some of the contents. The long-term management options taken into the detailed evaluation focussed on recovery of the mobile oil and sediment phases and looked at the potential to take a targeted approach which would increase efficiency of recovery but also limit the extent of disturbance to the drill cuttings on the cell tops. Potential treatment options were identified and screened (as reported in Fairfield, 2018c) and four viable options were taken forward for further study work – these are shown overleaf.



Option 1 – High Case – Oil and Sediment Removal

This would require 31 cell penetrations. Mobile oil would be recovered from 74 cells (31 cells accessed directly and 43 cells accessed indirectly). Sediment would be recovered from 8 cells. This option would require removal of all cell top drill cuttings.

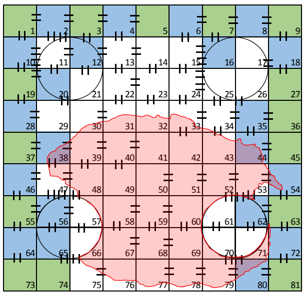
Mobile oil recovery = 599 m^3 / Sediment recovery = 270 m^3.



Option 2 – Mid-case – Oil and Sediment Removal

This would require 18 cell penetrations. Mobile oil would be recovered from 41 cells (18 cells accessed directly and 23 cells accessed indirectly). Sediment would be recovered from 4 cells. This option would require limited removal of cell top drill cuttings.

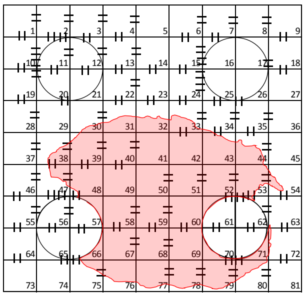
Mobile oil recovery = 299 m^3 / Sediment recovery = 147 m^3.



Option 3 – Mid-case – Oil Removal

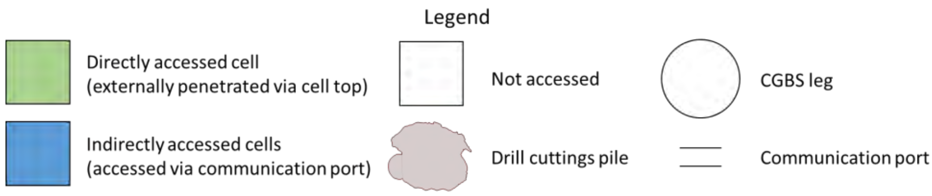
This would require 15 cell penetrations. Mobile oil would be recovered from 36 cells (15 cells accessed directly and 21 cells accessed indirectly). Sediment would not be recovered from any cells. This option would require limited removal of cell top drill cuttings.

Mobile oil recovery = 274 m^3 / Sediment recovery = 0 m^3.



Option 4 – Leave *In situ*

All cell contents left *in situ* with no removal or remediation.



Following the Comparative Assessment recommendation to decommission the substructure *in situ*, a further evaluation was undertaken to assess options for the long-term management of the cell contents, as described above.

In order to inform the cell contents Comparative Assessment, Fairfield conducted an intensive study to better understand and characterise the contents of the cells (Fairfield, 2018c). The study then progressed on using this inventory as the base case to evaluate potential management options. The study also demonstrated that full removal of the residual cell contents is only technically feasible should the whole CGBS be removed and in doing so there would be inevitable release of some of the contents.

The long-term management options considered for Comparative Assessment focussed on recovery of the mobile oil and sediment phases and looked at the potential to take a targeted approach which would increase efficiency of recovery but also limit the extent of disturbance to the drill cuttings on the cell tops. Potential treatment options were identified and screened (as reported in Fairfield, 2018c) and four viable options were taken forward to the detailed evaluation phase of the Comparative Assessment, these are shown overleaf.

The assessment evaluated the options using a range of criteria covering safety, environmental, technical, societal and economic aspects. Further details of the comparative assessment process can be found in the Dunlin Alpha Comparative Assessment Report (Fairfield, 2018b).

The assessment of the cell contents management options has identified that technical challenges associated with the three removal options would limit the quantity of cell contents material that could be recovered. This is due to the physical restrictions of the cell compartments, the ability to adapt and upscale technology to locate and extract the contents and the physical properties of the materials to be recovered. As a result, while further recovery of cell contents may reduce the quantity of contents released to the marine environment, the overall reduction in environmental impact would be indiscernible.

The environmental impact associated with both the gradual release of cell contents and an unplanned instantaneous release due to a high energy impact were assessed to inform the comparative assessment process. For both scenarios, the environmental impact was assessed to be not significant. A detailed assessment of the environmental impact assessment associated with cell contents release scenarios is provided in Section 5. In addition, operational marine impacts, atmospheric emissions and resource consumption associated with the leave *in situ* option were all assessed as having less environmental impact than the removal options.

The recommendation from the Cell Contents Comparative Assessment process is to leave the cell contents *in situ*, with no further removal or remediation.

2.2.3. Selected Decommissioning Strategy

The decommissioning process decision outcomes, supported by an appropriate amount of specialist study work, are summarised in Table 2.8. The Dunlin Alpha Comparative Assessment Report outlines the decision-making process and procedure for the CGBS and cell contents in more detail.

Table 2.8 Recommendations for Dunlin Alpha Decommissioning

Infrastructure type	Subject of Comparative Assessment?	Decommissioning recommendation
Topsides	No	Full removal
CGBS	Yes	Leave *in situ*, including transitions – paint and install cathodic protection. Install navaid.
Cell Contents	Yes	Leave *in situ*
Drill Cuttings	No	Leave *in situ*

2.3. Decommissioning Activities

2.3.1. Schedule

Fairfield anticipates executing the Dunlin Alpha Decommissioning Project activities in 2021; an indicative schedule for the work is shown in

Figure 2.11. However, the specific timing of decommissioning activities will be agreed with BEIS and with the Health and Safety Executive (HSE) and applications for all relevant permits and consents will be submitted and approval sought prior to activities taking place.

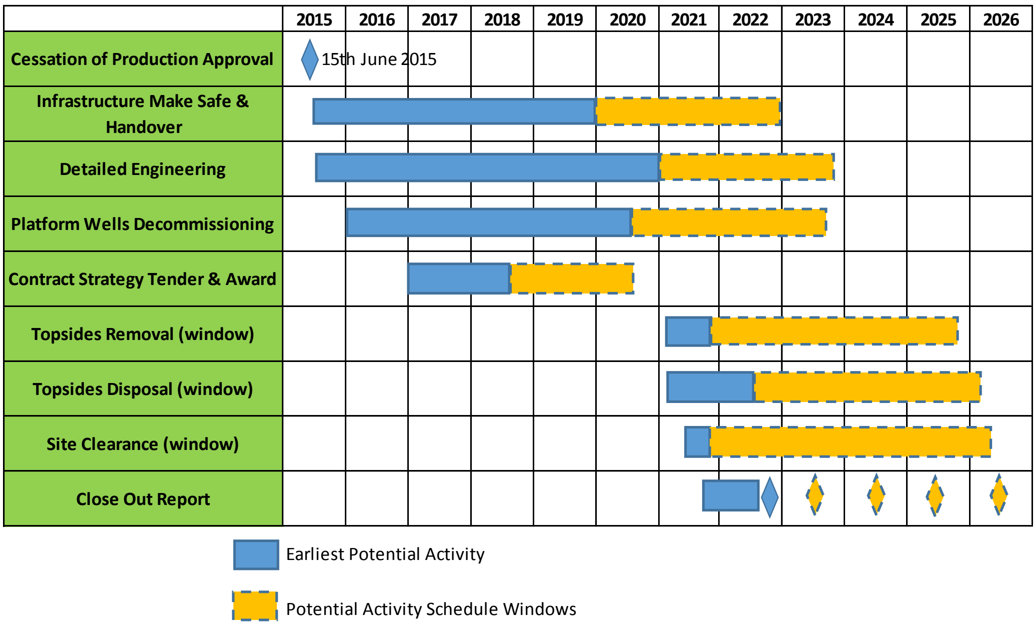


Figure 2.11 Indicative Schedule

Fairfield will select one or more appropriate contractors to mobilise a fleet comprising vessels with a range of crane capabilities for lifting objects of different sizes and weights, vessels that can support topsides activities, vessels that can support underwater operations (including Remotely Operated Vehicle deployment) and survey vessels. Vessels will be in the field for up to 500 days while completing the scopes detailed in the schedule.

2.3.2. Preparation for Decommissioning

2.3.2.1. Well Plug and Abandonment

Note: Well plugging and abandonment (P&A) is not within the scope of this Environmental Appraisal, and it has been or will be assessed as part of well intervention and marine licence applications. A description is included here to describe the activities leading up to the point that the decommissioning activities that are assessed within this report will begin.

All 45 Dunlin platform wells are in the process of being permanently abandoned as part of a large-scale plug and abandonment (P&A) campaign which commenced in January 2016. Well abandonment is achieved by the establishment of barriers (i.e. the placement of cement plugs in the well) which are necessary to isolate permeable zones, fluids and pressures permanently. Well P&A activities are conducted in accordance with the policies and standards outlined in the UK Oil & Gas Guidelines for the Abandonment of Wells (OGUK, 2015b), Fairfield's Well Design and Operations Management System and the Fairfield Well Abandonment Basis of Design Document.

2.3.2.2. Preparation of Topsides

Note: These installation operations are not within the scope of this Environmental Appraisal, and they have been or will be assessed as part of ongoing operations of the facilities. A description is included here to describe the activities leading up to the point that the decommissioning activities that are assessed within this report will begin.

Production operations on Dunlin Alpha ceased in June 2015. Since then, the Make Safe and Handover (MSH) team have been responsible for transitioning the Dunlin Alpha from a live production installation to a state of permanent shutdown, with process equipment flushed, purged, and isolated in preparation for the topsides removal phase.

During flushing and isolation activities, all the processing systems on the installation will be progressively depressurised and rendered safe for removal operations. Where possible, pipework and tanks will be visually inspected and may be further treated should any sources of potential spills of oils and other fluids be identified.

MSH activities will also be undertaken to prepare the concrete legs for flooding prior to topsides removal. These activities will involve the flushing and purging of pipework, and the removal of hazardous materials and substances from within the legs.

Environmental impacts associated with these activities will be managed through the application of permits (either under existing permits, under existing permits with amendments or under new permits) in accordance with relevant regulations (e.g. Offshore Chemical Regulations 2002 (as amended), Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended)).

2.3.2.3. Removal of Installation Conductors

Note: Conductor removals is not within the scope of this Environmental Appraisal, and it has been or will be assessed as part of well intervention and marine licence applications. A description is included here to describe the activities leading up to the point that the decommissioning activities that are assessed within this report will begin.

In preparation of installation removal operations, the 45 platform well conductors will be removed as part of Phase 3 of the Dunlin well abandonment programme. These operations will involve cutting each conductor at a depth just above the lower Conductor Guide Frame and removing them to shore for recycling or disposal. Any discharges from these operations will be managed in accordance with approved environmental permits, as required.

2.3.3. Decommissioning Activities

2.3.3.1. Topsides

There are four topsides removal options which Fairfield expect to be available at the time of decommissioning; these are summarised in Figure 2.12 and Table 2.9. At this stage, Fairfield has not determined the specific method by which the topsides will be removed and returned to shore; the project reference case is reverse installation, but the decision will depend to some degree on the proposals made by the eventual contractor. In all cases, the topsides will be fully removed to shore.

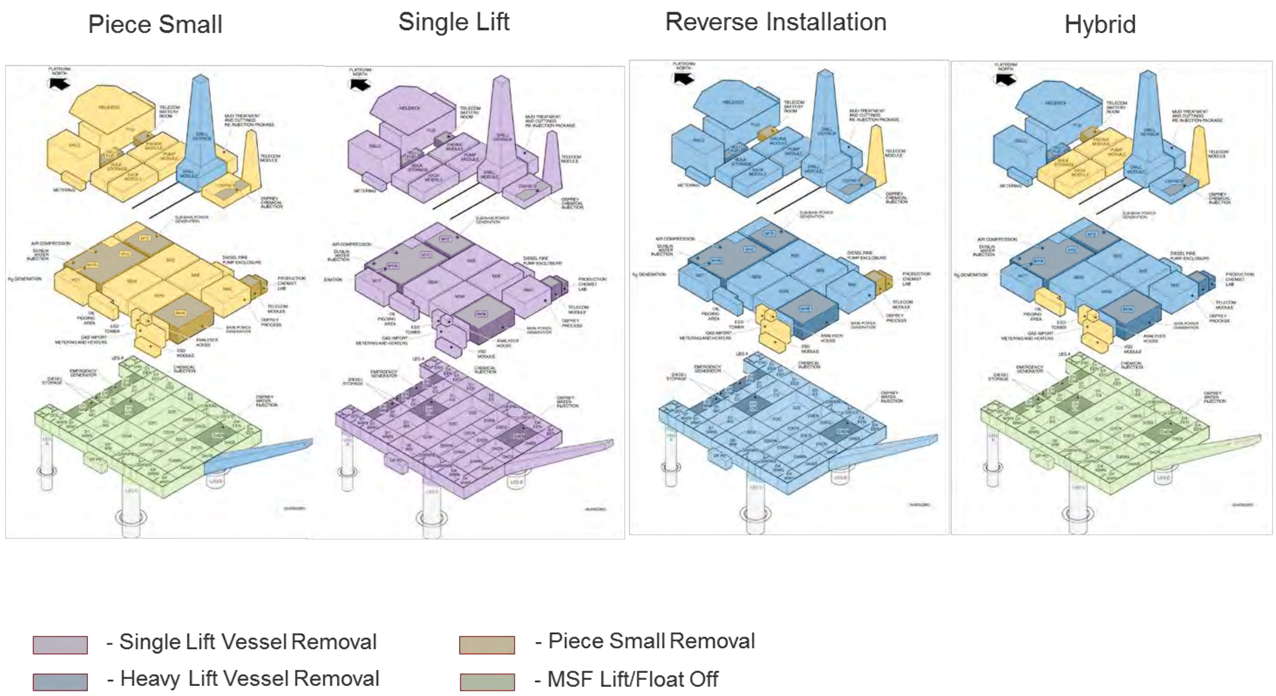


Figure 2.12 Topsides Removal Options

Table 2.9 Details on Options for Topsides Removal

Piece-small
In the piece-small option, the topsides modules (the various pieces that make up the topsides) and other facilities would be dismantled offshore using mechanical excavators equipped with cutting tools. Manual cutting techniques would be used to breakdown the facilities into smaller, manageable sections. These would then be sorted and loaded into containers for transportation to shore on supply vessels. There would be two main phases to this option: Stage 1: All cables and hazardous waste would be removed from or secured within each of the topsides modules in turn. Module internals (vessels, pipes and secondary structures) would then be removed. The remaining module structures would then be cut into container-sized sections. The accommodation, life support and utility systems would also be removed. Stage 2: After removal of all the modules and facilities, the MSF would be lifted or floated off using a suitable vessel (i.e. HLV or barge arrangement).
Single lift
In the single lift option, an HLV capable of lifting the entire topsides in one lift would be used. The topsides would be prepared for this by a combination of making sure modules were secured for transport and structural strengthening of the topsides, if required. The topsides would be transported to the designated disposal yard by HLV or cargo barge where they would then be transferred to the quayside for dismantling.
Reverse installation
For reverse installation, the modules would be separated and each module removed individually, or in groups, by a crane on a HLV onto the removal vessel deck or adjacent cargo barge. Modules would then be transported in batches to an onshore disposal yard. The modules may then be assigned for re-use or broken down for recycling or disposal. The MSF would be removed via a single lift or in sections and also be broken down in this manner.
Hybrid
The hybrid removal methodology uses a combination of piece small and reverse installation to remove larger sections of the topsides modules and appurtenances. The MSF would be removed in the same manner as piece small (i.e. by HLV or barge arrangement).

2.3.3.2. CGBS

It is proposed that the CGBS is decommissioned *in situ,* with the four CGBS transitions remaining in place (as per Option 9 detailed in Section 2.1.3).

The transitions will have their internal walls painted at the splash zone and a cathodic protection system installed externally in order to reduce the corrosion rate. The concrete legs will be partially flooded to reduce the differential pressure across the CGBS cells groups, and the steel transitions will be sealed with an appropriately galvanised steel roof to enable a navaid and navaid support frame to be installed on top of one of the transitions.

The conductors will be cut just above the lower guide frames and returned to shore along with the upper two guide frames. The lower guide frame will be left attached to the concrete legs.

2.3.3.3. Cell Contents

It is proposed that the cell contents are decommissioned *in situ* (as per Section 2.2.2.3). No intervention work is required to facilitate this decommissioning option.

2.3.3.4. Drill Cuttings

As it is proposed to decommission the CGBS *in situ* (as per Option 9 detailed in Section 2.1.3) and as the drill cuttings are below the OSPAR 2006/5 thresholds for leaching and persistence (Section 2.1.5), it is the intention of Fairfield to leave the drill cuttings pile *in situ* with minimal disturbance. No intervention work is required on the drill cuttings to facilitate this decommissioning scenario.

2.3.3.5. Marine Growth

As part of preparation activities for decommissioning, visual inspections of the subsea parts of the Dunlin Alpha installation were commissioned by Fairfield. The objective of these studies was to record information on the types and levels of marine fouling growth present on the CGBS (including transitions, conductors and Conductor Guide Frames). A marine growth assessment was undertaken (Xodus, 2017) to assess the total marine growth present. A total of 1,400 tonnes of marine growth is estimated to be on the infrastructure. However, as it is proposed to decommission the CGBS *in situ* the vast majority of marine growth would not be removed. For infrastructure that is to be brought onshore, it is Fairfield's intention to remove marine growth offshore. Fairfield is aware of stakeholder's ongoing work to limit the return of marine growth to shore and will continue to engage on this topic. Should it be necessary, Fairfield will discuss with BEIS the requirement to submit a Marine Licence for marine growth removal.

2.3.3.6. Navigational Aids (Navaids)

A requirement of decommissioning the CGBS with transitions *in situ* is that a navaid is required in order to identify hazards to other sea users. Fairfield commissioned Atkins to complete a navaid study to determine the appropriate solution for the navaid at the Dunlin Alpha installation (Atkins, 2017a). Whilst the specific navaid technology to be used is still to be defined, it will be a unit that can be transported from ship to structure underslung by helicopter and dropped in place onto a previously installed docking pole as illustrated in Figure 2.13. Replacement navaids would be swapped out in the same manner.

Figure 2.13 Example of a Navaid Being Installed by Helicopter

2.3.4. Post-Decommissioning Survey and Debris Clearance

Upon completion of decommissioning operations, an environmental survey and post-decommissioning debris clearance survey will be conducted within the Dunlin Alpha installation 500 m safety zone. The scope and scheduling of debris survey and clearance activities will be discussed and agreed with the regulator. Following the removal of any debris, an independent verification of completion of the seabed clearance operations will be undertaken and a seabed clearance certificate will be issued.

2.3.5. Monitoring

Where, based on the information provided in the Decommissioning Programme, the regulator (OPRED) determines that post-decommissioning monitoring is necessary, Fairfield will develop a survey strategy in consultation with the regulator. The agreed survey strategy may require multiple surveys, with the first being part of the close-out report process and further surveys scheduled for some time after the initial post-decommissioning sampling. The frequency of the monitoring is likely to be determined through a risk-based approach based on the findings from each subsequent survey. In addition, planned inspection and replacement of the navaid and a visual inspection of the CGBS will be undertaken.

2.3.6. Onshore Dismantling and Disposal

The Dunlin topsides will be removed and delivered to an appropriately licensed onshore dismantling site, or sites. Although the dismantling site has not yet been selected, it will be chosen from a shortlist of existing onshore disposal yards and no new facilities will be required. At the dismantling site(s):

- Equipment suitable for reuse will be segregated;

- Pipework that has been in contact with hydrocarbons and potentially contains NORM will be assessed, and removed to a licensed facility if decontamination is necessary;
- Marine growth that has not fallen off structures in transit will be removed and sent for appropriate disposal (Section 5.5 provides further detail on handling of marine growth); and
- Topsides sections will be stripped to recover copper cable and other recyclable materials.

Management of waste from these activities is detailed in Section 5.5.

3. Environmental Appraisal Methodology

3.1. Identification of Environmental Issues

An Environmental Appraisal in support of a Decommissioning Programme should be focused on the key issues related to the specific activities proposed; the impact assessment write-up should be proportionate to the scale of the project and to the environmental sensitivities of the project area. This does not mean, however, that the impact assessment process should be any less robust than for a statutory impact assessment or consider any fewer impact mechanisms. To this end, Fairfield undertook an environmental impact identification exercise (ENVID) early in the Environmental Appraisal process. This ENVID workshop identified the key environmental sensitivities, discussed the sources of potential impact and identified those sources which required further assessment, the output of the ENVID is included in Appendix A – ENVID Matrix. The decision on which issues required further study and assessment was based on the specific proposed activities and environmental sensitivities around the Dunlin Alpha installation, on a review of industry experience of decommissioning impact assessment and on an assessment of wider stakeholder interest informed in part by the stakeholder engagement described in Section 3.2.

Table 3.1 provides a summary of the key environmental sensitivities identified by the ENVID process. Further detail is provided in Appendix A – ENVID Matrix, including an explanation of why some topics were assessed in further detail and why some were considered sufficiently well-understood to require not further assessment.

Table 3.1 Summary of the Impact Identification Exercise, with the Justification for the Inclusion and Exclusion of Impact Sources

Potential impact or mechanism	Further assessment?	Rationale
Environmental issues		
Gradual release of cell contents over time	Yes	As the structure degrades over time, communication paths between the cell internal and external environments will form. A release of cell contents is likely to occur as a result of long term water ingress, rather than currents forcing contents out of the cells. Such a release would see mobile oil and water containing aromatics and heavy metals released to the water column. Given the potential release, and given that the issue has been raised as a key area of concern for stakeholders, and given the novel nature of the impact mechanism, further assessment has been undertaken and is presented in Section 5.1.

Potential impact or mechanism	Further assessment?	Rationale
Disturbance of drill cuttings through collapse of concrete structure, or objects falling during structure collapse	Yes	Although the cuttings pile does not exceed OSPAR 2006/5 thresholds to leave *in situ*, it is possible that the cuttings piles could be disturbed during decommissioning activities, should objects be dropped onto them, or in the longer-term as parts of the concrete structure begins to degrade and fall towards the seabed. Given this potential interaction, and given that the issue has been raised as a key area of concern for stakeholders, this has been assessed further and is discussed in Section 5.3.
Release of cell contents through collapse of concrete structure, objects falling during structure collapse, or collision from a third party	Yes	The worst-case release scenario from the cells at any one point in time is considered to result from a steel transition falling and penetrating the cells. It is estimated that such an event could release between 50 -100 m^3, from a maximum of four cells. Despite the low probability of a release occurring (it is considered that the fall would not have sufficient energy to pierce the cells), this issue has been raised as a key area of concern for stakeholders. Given this interest, and the novel nature of the impact mechanism, further assessment has been undertaken and is presented in Section 5.2.
Societal issues		
Physical presence of infrastructure decommissioned *in situ* in relation to other sea users	Yes	It is proposed to decommission the CGBS *in situ*, with transitions in place. The OSPAR and UK Regulatory base case is for full removal of the structure where possible (taking into account safety, environmental, technical feasibility, societal and economic factors). Additionally, decommissioning infrastructure *in situ* has been raised as a key stakeholder concern in this and many previous decommissioning projects. On this basis, further assessment of the long-term physical presence of the infrastructure in relation to other sea users has been undertaken. Specifically, this assessment has focussed on the potential interaction with fisheries in the longer-term.

3.2. Stakeholder Engagement

Fairfield recognises that early and ongoing engagement with stakeholders is a critical part of the development of robust, respectful programmes for the decommissioning of North Sea installations. Key activities have included issue of an environmental scoping report, a number of open information events and Comparative Assessment workshops with attendance from regulators and advisors. Further detail is provided in the Stakeholder Report (Fairfield, 2018d).

As well as working with key regulatory and environmental stakeholders, Fairfield has sought to understand the lessons that other UKCS operators have learned during their decommissioning activities to date. In addition, Fairfield makes information available to the general public via a dedicated decommissioning website.

As a detailed log of areas of interest raised during consultation is presented in the Stakeholder Report, it is not repeated here. However, the key environmental items identified by stakeholders and how they have been assessed in the Environmental Appraisal are as follows:

- Gradual release of cell contents over time.
    - The novel nature of this impact mechanism mean that it has been raised on a number of occasions by stakeholders. Fairfield recognises the potential impact related to such a release over a prolonged period of time, and further assessment has been undertaken and is presented in Section 5.1.
- Instantaneous release of cell contents after decommissioning.
    - The outcome of the Comparative Assessment for the cell contents concluded that the contents should be left *in situ* without further remediation. An event resulting in an instantaneous release of the cell contents at some future point is understood to be possible and, given the novel nature of such a potential impact, this is assessed further in Section 5.2.
- Disturbance of the drill cuttings pile after decommissioning.
    - As described in Section 2.1.5, the drill cuttings present at the foot of the installation are below the relevant OSPAR thresholds. Since it is proposed that the CGBS will be decommissioned *in situ*, the drill cuttings will not be disturbed during decommissioning activities. It is possible, however, that the cuttings could be disturbed as the concrete structure degrades, and this is assessed in Section 5.3.
- Loss of access by the permanent presence of the CGBS decommissioned *in situ*.
    - The presence of infrastructure decommissioned *in situ* is recognised by Fairfield as a key stakeholder concern in terms of societal impact. In addition, the decommissioning *in situ* of infrastructure is seen to be of key Regulatory interest. As such, this impact mechanism is discussed further in Section 5.3.1.
- The management of waste associated with the decommissioning activities.
    - This is discussed further in Section 5.5.

3.3. Environmental Significance

3.3.1. Overview

This section provides detail on how the Environmental Appraisal process has been applied to the Dunlin Alpha Decommissioning Project and describes the key components that have fed into the assessment. Figure 3.1 below presents an overview flow diagram of the process.

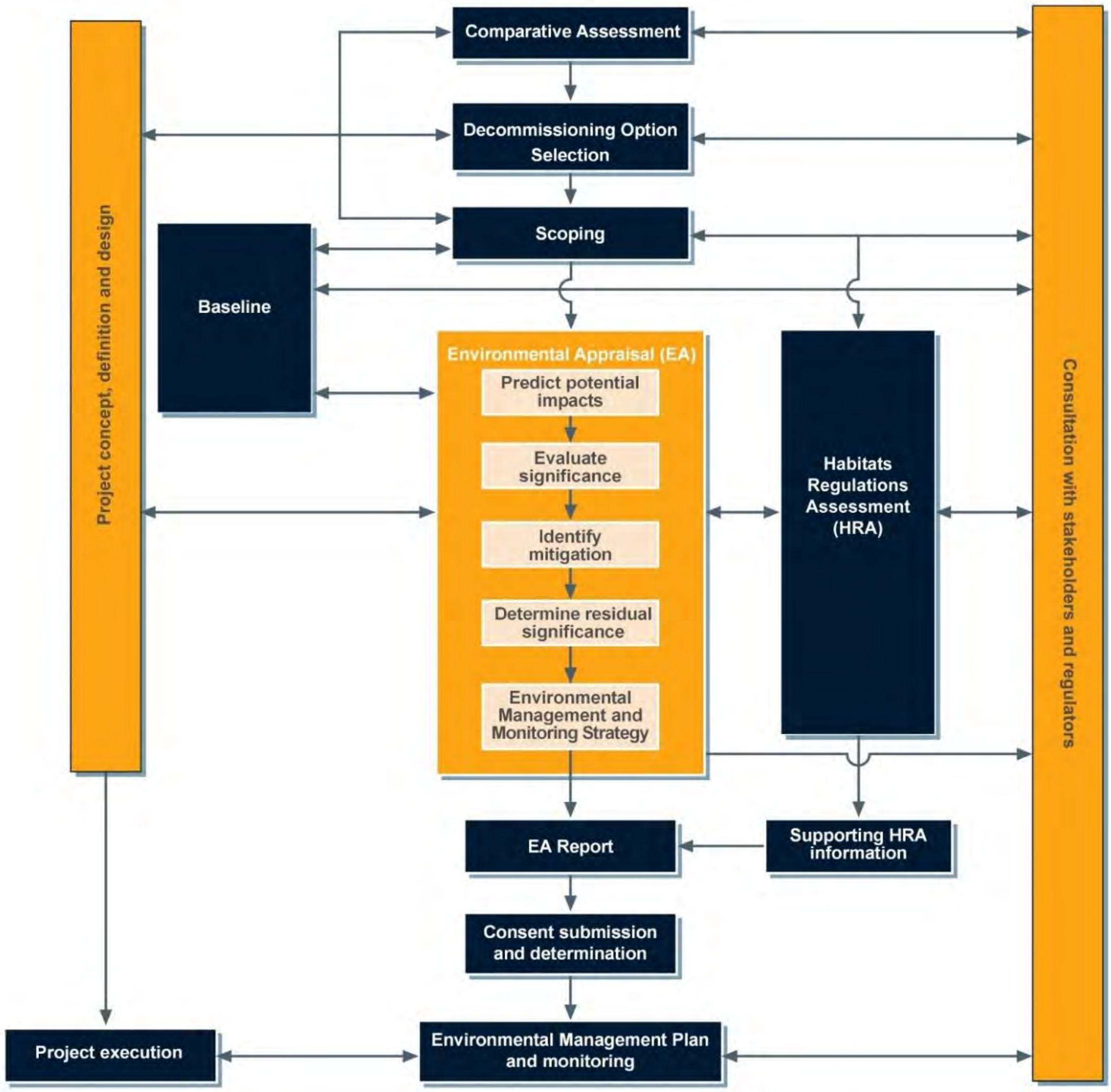


Figure 3.1 The Environmental Appraisal process

3.3.2. Baseline Characterisation and Receptor Identification

In order to make an assessment of potential impacts on the environment it was necessary to firstly characterise the different aspects of the environment that could potentially be affected (the baseline environment). The baseline environment has been described in Section 4 and is based on desk studies combined with additional site-specific studies such as surveys and modelling where required. Information obtained through consultation with key stakeholders was also used to help characterise specific aspects of the environment in more detail.

Where data gaps and uncertainties remained (e.g. where there are no suitable options for filling data gaps), as part of the Environmental Appraisal process these have been documented and taken into consideration as appropriate as part of the assessment of impact significance.

The Environmental Appraisal process requires identification of the potential receptors that could be affected by the Dunlin Alpha Decommissioning Project (e.g. seabed species and habitats). High level receptors are identified within the impact assessments (Section 5).

3.3.3. Impact Definition

3.3.3.1. Impact magnitude

Determination of impact magnitude requires consideration of a range of key impact criteria including:

- Nature of impact, whether it be beneficial or adverse;
- Type of impact, be it direct or indirect etc.;
- Size and scale of impact, i.e. the geographical area;
- Duration over which the impact is likely to occur i.e. days, weeks;
- Seasonality of impact, i.e. is the impact expected to occur all year or during specific times; and
- Frequency of impact, i.e. how often the impact is expected to occur.

Each of these variables are expanded upon in Table 3.2 - Table 3.6 to provide consistent definitions across all Environmental Appraisal topics. In each impact assessment, these terms are used in the assessment summary table to summarise the impact and are enlarged upon as necessary in any supporting text. With respect to the nature of the impact (Table 3.2), it should be noted that all impacts discussed in this Environmental Appraisal report are adverse unless explicitly stated otherwise.

Table 3.2 Nature of Impact

Nature of impact	Definition
Beneficial	Advantageous or positive effect to a receptor (i.e. an improvement).
Adverse	Detrimental or negative effect to a receptor.

Table 3.3 Type of Impact

Type of impact	Definition
Direct	Impacts that result from a direct interaction between the Dunlin Alpha Decommissioning Project and the receptor. Impacts that are actually caused by the activities.
Indirect	Reasonably foreseeable impacts that are caused by the interactions of the Dunlin Alpha Decommissioning Project but which occur later in time than the original, or at a further distance. Indirect impacts include impacts that may be referred to as ‘secondary’, ‘related’ or ‘induced’.

Type of impact	Definition
Cumulative	Impacts that act together with other impacts (including those from any concurrent or planned future third party activities) to affect the same receptors as the Dunlin Alpha Decommissioning Project. Definition encompasses "in-combination" impacts.

Table 3.4 Duration of Impact

Duration	Definition
Short term	Impacts that are predicted to last for a short duration (e.g. less than one year).
Temporary	Impacts that are predicted to last a limited period (e.g. a few years). For example, impacts that occur during the decommissioning activities and which do not extend beyond the main activity period for the works or which, due to the timescale for mitigation, reinstatement or natural recovery, continue for only a limited time beyond completion of the anticipated activity
Prolonged	Impacts that may, although not necessarily, commence during the main phase of the decommissioning activity and which continue through the monitoring and maintenance, but which will eventually cease.
Permanent	Impacts that are predicted to cause a permanent, irreversible change.

Table 3.5 Geographical Extent of Impact

Geographical extent	Description
Local	Impacts that are limited to the area surrounding the Dunlin Alpha Decommissioning Project footprint and associated working areas. Alternatively, where appropriate, impacts that are restricted to a single habitat or biotope or community.
Regional	Impacts that are experienced beyond the local area to the wider region, as determined by habitat/ecosystem extent.
National	Impacts that affect nationally important receptors or protected areas, or which have consequences at a national level. This extent may refer to either Scotland or the UK depending on the context.
Transboundary	Impacts that could be experienced by neighbouring national administrative areas.
International	Impacts that affect areas protected by international conventions, European and internationally designated areas or internationally important populations of key receptors (e.g. birds, marine mammals).

Table 3.6 Frequency of Impact

Frequency	Description
Continuous	Impacts that occur continuously or frequently.
Intermittent	Impacts that are occasional or occur only under a specific set of circumstances that occurs several times during the course of the Dunlin Alpha Decommissioning Project. This definition also covers such impacts that occur on a planned or unplanned basis and those that may be described as 'periodic' impacts.

3.3.3.2. Impact Magnitude Criteria

Overall impact magnitude requires consideration of all impact parameters described above. Based on these parameters, magnitude can be assigned following the criteria outlined in Table 3.7. The resulting effect on the receptor is considered under vulnerability and is an evaluation based on scientific judgement.

Table 3.7 Impact Magnitude Criteria

Magnitude	Criteria
Major	Extent of change: Impact occurs over a large scale or spatial geographical extent and/or is long term or permanent in nature. Frequency/intensity of impact: high frequency (occurring repeatedly or continuously for a long period of time) and/or at high intensity.
Moderate	Extent of change: Impact occurs over a local to medium scale/spatial extent and/or has a prolonged duration. Frequency/intensity of impact: medium to high frequency (occurring repeatedly or continuously for a moderate length of time) and/or at moderate intensity or occurring occasionally/intermittently for short periods of time but at a moderate to high intensity.
Minor	Extent of change: Impact occurs on-site or is localised in scale/spatial extent and is of a temporary or short term duration. Frequency/intensity of impact: low frequency (occurring occasionally/intermittently for short periods of time) and/or at low intensity.
Negligible	Extent of change: Impact is highly localised and very short term in nature (e.g. days/few weeks only).
Positive	An enhancement of some ecosystem or population parameter.
Notes: Magnitude of an impact is based on a variety of parameters. Definitions provided above are for guidance only and may not be appropriate for all impacts. For example, an impact may occur in a very localised area (minor to moderate) but at very high frequency/intensity for a long period of time (major). In such cases informed judgement is used to determine the most appropriate magnitude ranking and this is explained through the narrative of the assessment.	

3.3.3.3. Impact Likelihood for Unplanned and Accidental Events

The likelihood of an impact occurring for unplanned/accidental events is another factor that is considered in this impact assessment. This captures the probability that the impact will occur and also the probability that the receptor will be present and is based on knowledge of the receptor and experienced professional judgement. Consideration of likelihood is described in the impact characterisation text and used to provide context to the specific impact being assessed in topic specific chapters as required.

3.3.4. Receptor Definition

3.3.4.1. Overview

As part of the assessment of impact significance it is necessary to differentiate between receptor sensitivity, vulnerability and value. The sensitivity of a receptor is defined as 'the degree to which a receptor is affected by an impact' and is a generic assessment based on factual information whereas an assessment of vulnerability, which is defined as 'the degree to which a receptor can or cannot cope with an adverse impact' is based on professional judgement taking into account an number of factors, including the previously assigned receptor sensitivity and impact magnitude, as well as other factors such as known population status or condition, distribution and abundance.

3.3.4.2. Receptor Sensitivity

Example definitions for assessing the sensitivity of a receptor are provided in Table 3.8.

Table 3.8 Sensitivity of Receptor

Receptor sensitivity	Definition
Very high	Receptor with no capacity to accommodate a particular effect and no ability to recover or adapt.
High	Receptor with very low capacity to accommodate a particular effect with low ability to recover or adapt.
Medium	Receptor with low capacity to accommodate a particular effect with low ability to recover or adapt.
Low	Receptor has some tolerance to accommodate a particular effect or will be able to recover or adapt.
Negligible	Receptor is generally tolerant and can accommodate a particular effect without the need to recover or adapt.

3.3.4.3. Receptor Vulnerability

Information on both receptor sensitivity and impact magnitude is required to be able to determine receptor vulnerability. These criteria, described in Table 3.7 and Table 3.8, are used to define receptor vulnerability as per Table 3.9.

Table 3.9 Vulnerability of Receptor

Receptor vulnerability	Definition
Very high	The impact will have a permanent effect on the behaviour or condition on a receptor such that the character, composition or attributes of the baseline, receptor population or functioning of a system will be permanently changed.
High	The impact will have a prolonged or extensive temporary effect on the behaviour or condition on a receptor resulting in long term or prolonged alteration in the character, composition or attributes of the baseline, receptor population or functioning of a system.
Medium	The impact will have a short term effect on the behaviour or condition on a receptor such that the character, composition, or attributes of the baseline, receptor population or functioning of a system will either be partially changed post development or experience extensive temporary change.
Low	Impact is not likely to affect long term function of system or status of population. There will be no noticeable long term effects above the level of natural variation experience in the area.
Negligible	Changes to baseline conditions, receptor population of functioning of a system will be imperceptible.

It is important to note that the above approach to assessing sensitivity/vulnerability is not appropriate in all circumstances and in some instances professional judgement has been used in determining sensitivity. In some instances, it has also been necessary to take a precautionary approach where stakeholder concern exists with regard to a particular receptor. Where this is the case, this is detailed in the relevant impact assessment in Section 5.

3.3.4.4. Receptor value

The value or importance of a receptor is based on a pre-defined judgement based on legislative requirements, guidance or policy. Where these may be absent, it is necessary to make an informed judgement on receptor value based on perceived views of key stakeholders and specialists. Examples of receptor value definitions are provided in Table 3.10.

Table 3.10 Value of Receptor

Value of receptor	Definition
Very high	Receptor of international importance (e.g. United Nations Educational, Scientific and Cultural Organisation (UNESCO) World Heritage Site). Receptor of very high importance or rarity, such as those designated under international legislation (e.g. EU Habitats Directive) or those that are internationally recognised as globally threatened (e.g. International Union for Conservation of Nature (IUCN) red list). Receptor has little flexibility or capability to utilise alternative area. Best known or only example and/or significant potential to contribute to knowledge and understanding and/or outreach.
High	Receptor of national importance (e.g. Nature Conservation Marine Protected Area (NCMPA), Marine Conservation Zone (MCZ)). Receptor of high importance or rarity, such as those which are designated under national legislation, and/or ecological receptors such as United Kingdom Biodiversity Action Plan (UKBAP) priority species with nationally important populations in the study area, and species that are near-threatened or vulnerable on the IUCN red list. Receptor provides the majority of income from the Dunlin Alpha installation area. Above average example and/or high potential to contribute to knowledge and understanding and/or outreach.
Medium	Receptor of regional importance. Receptor of moderate value or regional importance, and/or ecological receptors listed as of least concern on the IUCN red list but which form qualifying interests on internationally designated sites, or which are present in internationally important numbers. Any receptor which is active in the Dunlin Alpha installation area and utilises it for up to half of its annual income/activities. Average example and/or moderate potential to contribute to knowledge and understanding and/or outreach.
Low	Receptor of local importance. Receptor of low local importance and/or ecological receptors such as species which contribute to a national site, are present in regionally. Any receptor which is active in the Dunlin Alpha installation area and reliant upon it for some income/activities. Below average example and/or low potential to contribute to knowledge and understanding and/or outreach.

Value of receptor	Definition
Negligible	Receptor of very low importance, no specific value or concern. Receptor of very low importance, such as those which are generally abundant around the UK with no specific value or conservation concern. Receptor of very low importance and activity generally abundant in other areas/ not typically present in the Dunlin Alpha installation area. Poor example and/or little or no potential to contribute to knowledge and understanding and/or outreach.

3.3.5. Consequence and Significance of Potential Impact

3.3.5.1. Overview

Having determined impact magnitude and the sensitivity, vulnerability and value of the receptor, it is then necessary to evaluate impact significance. This involves:

- Determination of impact consequence based on a consideration of sensitivity, vulnerability and value of the receptor and impact magnitude;
- Assessment of impact significance based on assessment consequence;
- Mitigation; and
- Residual impacts.

3.3.5.2. Assessment of Consequence and Impact Significance

The sensitivity, vulnerability and value of receptor are combined with magnitude (and likelihood, where appropriate) of impact using informed judgement to arrive at a consequence for each impact, as shown in Table 3.11. The significance of impact is derived directly from the assigned consequence ranking. The assessment of consequence considers mitigation measures that are embedded within the proposed activities.

Table 3.11 Assessment of Consequence

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Impact significance
Major consequence	Impacts are likely to be highly noticeable and have long term effects, or permanently alter the character of the baseline and are likely to disrupt the function and status/value of the receptor population. They may have broader systemic consequences (e.g. to the wider ecosystem or industry). These impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.	Significant
Moderate consequence	Impacts are likely to be noticeable and result in prolonged changes to the character of the baseline and may cause hardship to, or degradation of, the receptor population, although the overall function and value of the baseline/ receptor population is not disrupted. Such	Significant

Assessment consequence	Description (consideration of receptor sensitivity and value and impact magnitude)	Impact significance
	impacts are a priority for mitigation in order to avoid or reduce the anticipated effects of the impact.	
Low consequence	Impacts are expected to comprise noticeable changes to baseline conditions, beyond natural variation, but are not expected to cause long term degradation, hardship, or impair the function and value of the receptor. However, such impacts may be of interest to stakeholders and/or represent a contentious issue during the decision-making process, and should therefore be avoided or mitigated as far as reasonably practicable	Not significant
Negligible	Impacts are expected to be either indistinguishable from the baseline or within the natural level of variation. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not significant
Positive	Impacts are expected to have a positive benefit or enhancement. These impacts do not require mitigation and are not anticipated to be a stakeholder concern and/or a potentially contentious issue in the decision-making process.	Not significant

3.4. Cumulative Impact Assessment

Although the scope of this impact assessment is restricted to the decommissioning of the Dunlin Alpha installation facilities as outlined in Section 2, it is recognised that the decommissioning workscope will also occur in the context of the subsea decommissioning at Dunlin, Osprey and Merlin, and other oil and gas and non-oil and gas activities, with which there is the potential to interact. To this end, the impact assessments presented in Section 5 specifically consider the potential for cumulative impact within the definition of significance.

3.5. Transboundary Impact Assessment

The impact assessments presented in Section 5 contain sections which identify the potential for, and where appropriate, assessment of transboundary impacts. For the Dunlin Alpha Decommissioning Project, this needs to be considered given the proximity to the UK/Norway median line (11 km).

3.6. Habitats Regulations Assessment (HRA) and Nature Conservation Marine Protected Area Assessment

Under Article 6.3 of the Habitats Directive, it is the responsibility of the Competent Authority (in this case, BEIS) to undertake Appropriate Assessment, if necessary, of the potential impacts of a plan, programme or project, alone or in combination, on a Natura site (Special Area of Conservation, SAC, or Special Protection Area, SPA) in view of the site's conservation objectives and the overall integrity of that site. In a similar but separate process of assessing impact on protected sites, there is also a requirement under the Marine and Coastal Access Act for the Competent Authority to consider the potential for the proposed activities to impact upon

NCMPAs. As with SACs and SPAs, BEIS is the Competent Authority for NCMPAs with respect to oil and gas development. Where relevant, the impact assessments presented in Section 5 provide information on the potential for the proposed activities to affect the protected features of SPA, SAC and NCMPAs, or to affect ecological or geomorphological processes on which the SPAs, SACs and NCMPAs are dependent.

4. Environment Baseline

The Environmental Baseline characterisation describes the current conditions of the receiving environment with the study area, and is considered sufficient to allow the potential activity/receptor interactions and environmental sensitivities to be appropriately evaluated.

4.1. Weather and Sea Conditions

4.1.1. Wind

Wind speed in the vicinity of the Dunlin Alpha installation is generally described as being either a calm to gentle breeze in the range 0 – 6 m/s or a moderate to fresh breeze in the range 6 – 10 m/s. Calm winds occur for approximately 31% of the year and moderate winds for 34.5% of the year. Gale conditions occur most frequently during the winter months (October to March) with the percentage of winds at or above 14 m/s in January being greater than 30% (BODC, 1998). The 1-year maximum wind speed over 1 hour is 31.1 m/s (PhysE, 2012). Figure 4.1 shows a wind rose for the Project area.

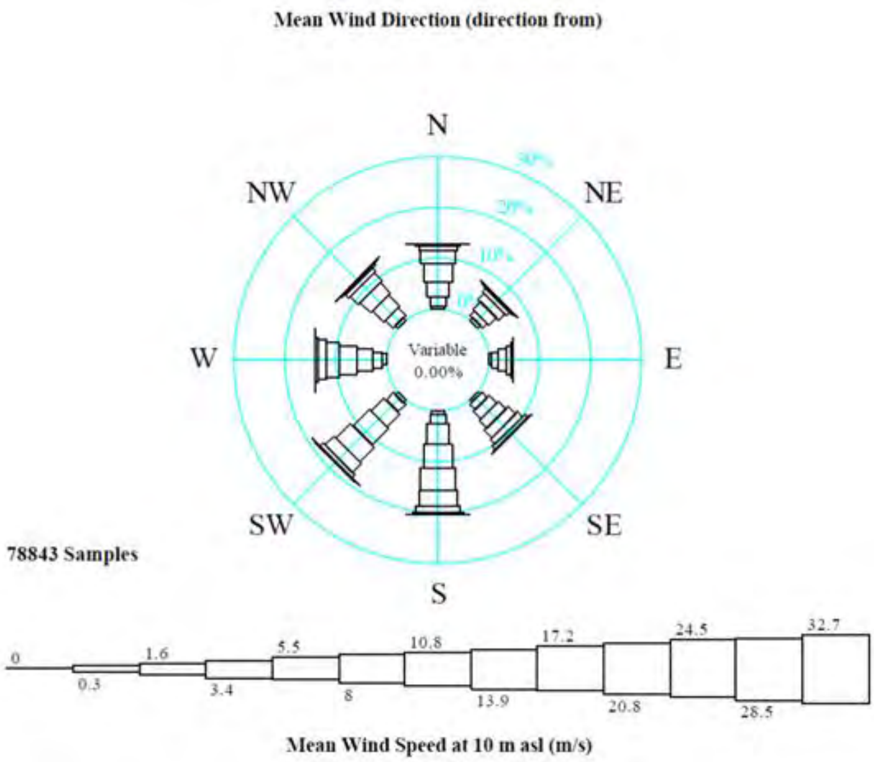


Figure 4.1 Wind Rose for Project Area (Fugro, 2001)

4.1.2. Sea

Wave height in the vicinity of the Project area ranges from a 1-year significant wave height of 11.5 m to a 1-year maximum wave height of 20.9 m. The maximum 100-year wave height is estimated to be 28.4 m (PhysE, 2012).

Average current velocities in the Project area are 0.5 m/s at the surface, decreasing to 0.2 m/s near the seabed (PhysE, 2012), with an average current speed through the water column of 0.46 m/s. The prevailing surface current in the area is in a southerly direction (Scottish Government, 2011).

Distinct density stratification occurs in the northern North Sea in the summer months at a depth of around 50 m and the thermocline becomes increasingly distinct towards deeper water in the north. This stratification breaks down in September as the frequency and severity of storms increases, causing mixing in the water column (DECC, 2016). The average sea surface water temperature in the Project area varies seasonally between approximately 4°C in winter to around 17°C in summer. Sea bottom temperatures vary between 5°C in winter to 12°C in summer (PhysE, 2012).

4.2. Bathymetry and Seabed Conditions

4.2.1. Overview

As part of preparation for the Dunlin Alpha Decommissioning Project, and as part of earlier operation of the Greater Dunlin Area, the following surveys have been undertaken in recent years:

- Surveys at the Dunlin Alpha installation and cuttings pile:
  - Dunlin Field Pre-decommissioning Habitat Survey and Environmental Baseline Survey (EBS) (Fugro, 2016a, Fugro 2017);
  - Dunlin Alpha Pre-decommissioning Cuttings Assessment Survey (Fugro, 2018); and
  - Dunlin Development Debris Clearance, 'Mud Mound' and EBS (Gardline, 2009).
- Surveys in the wider area:
  - Dunlin Fuel Gas Import Route Survey (Gardline, 2011);
  - Dunlin Fuel Gas Import Pre-decommissioning Habitat Survey and EBS (Fugro 2016b; Fugro 2016c);
  - Dunlin to Northern Leg Gas Pipeline Route Survey (Gardline, 2010a);
  - Dunlin Power Import Cable Pre-decommissioning Habitat Survey and EBS (Fugro 2016d; Fugro 2016e); and
  - Quad 211 Infield Environmental Survey (Gardline, 2010b).

The surveys undertaken closest to the Dunlin Alpha installation are reported in Gardline (2009), Fugro (2016a), Fugro (2017) and Fugro (2018b). The locations of stations sampled during these surveys are presented in Figure 4.2. It should be noted that the Fugro (2016a), Fugro (2017) and Fugro (2018) reports all refer to stations that were sampled during a single survey, and these stations are therefore presented as a single survey in Figure 4.2. The stations with a "DFC" prefix are reported in Fugro (2016a) and Fugro (2017) (the Dunlin Field Pre-Decommissioning Habitat Survey and EBS). The stations with a "DCP" prefix were located on the cuttings pile, and are reported in the Dunlin Field Habitat Survey Report (Fugro, 2016a) and the Dunlin Alpha Pre-Decommissioning Cuttings Assessment Survey Report (Fugro, 2018), but not the Dunlin Field EBS Report (Fugro, 2017). The stations with a "CT" prefix were located on the Dunlin Alpha CGBS cell tops and are only reported in the Dunlin Alpha Pre-Decommissioning Cuttings Assessment Survey Report (Fugro, 2018). The description of bathymetry, seabed conditions and benthos (Section 4.2 and 0) in the Project area, draws on these four survey reports.

Sampling stations for the wider area surveys listed above are presented in Figure 4.3. The results of these surveys were used to provide a baseline with which to compare the survey stations close to Dunlin Alpha.

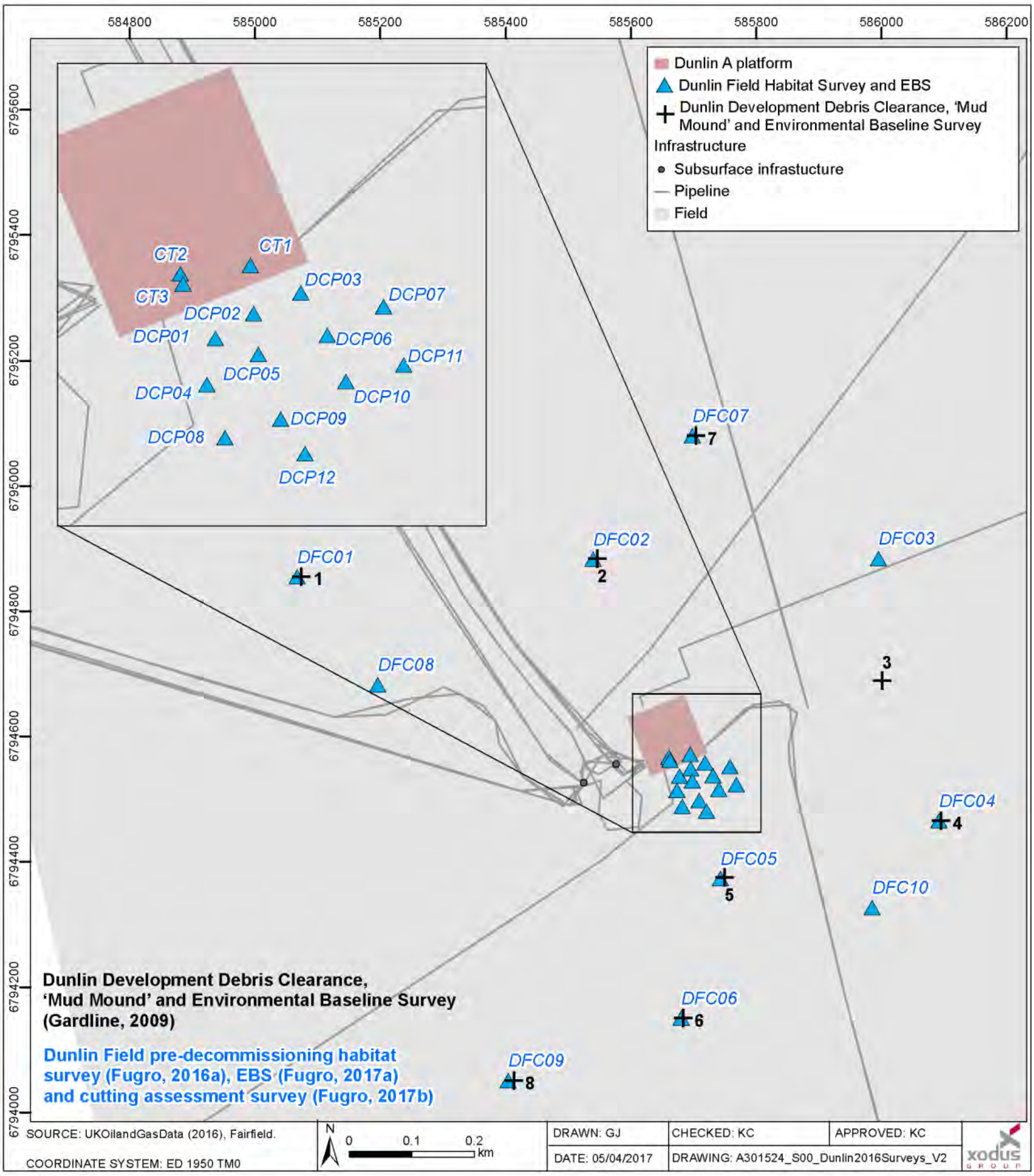


Figure 4.2 Environmental Survey Station Locations Close to the Dunlin Alpha Installation and Cuttings Pile (Gardline, 2009, Fugro, 2016a, Fugro, 2017, Fugro, 2018)

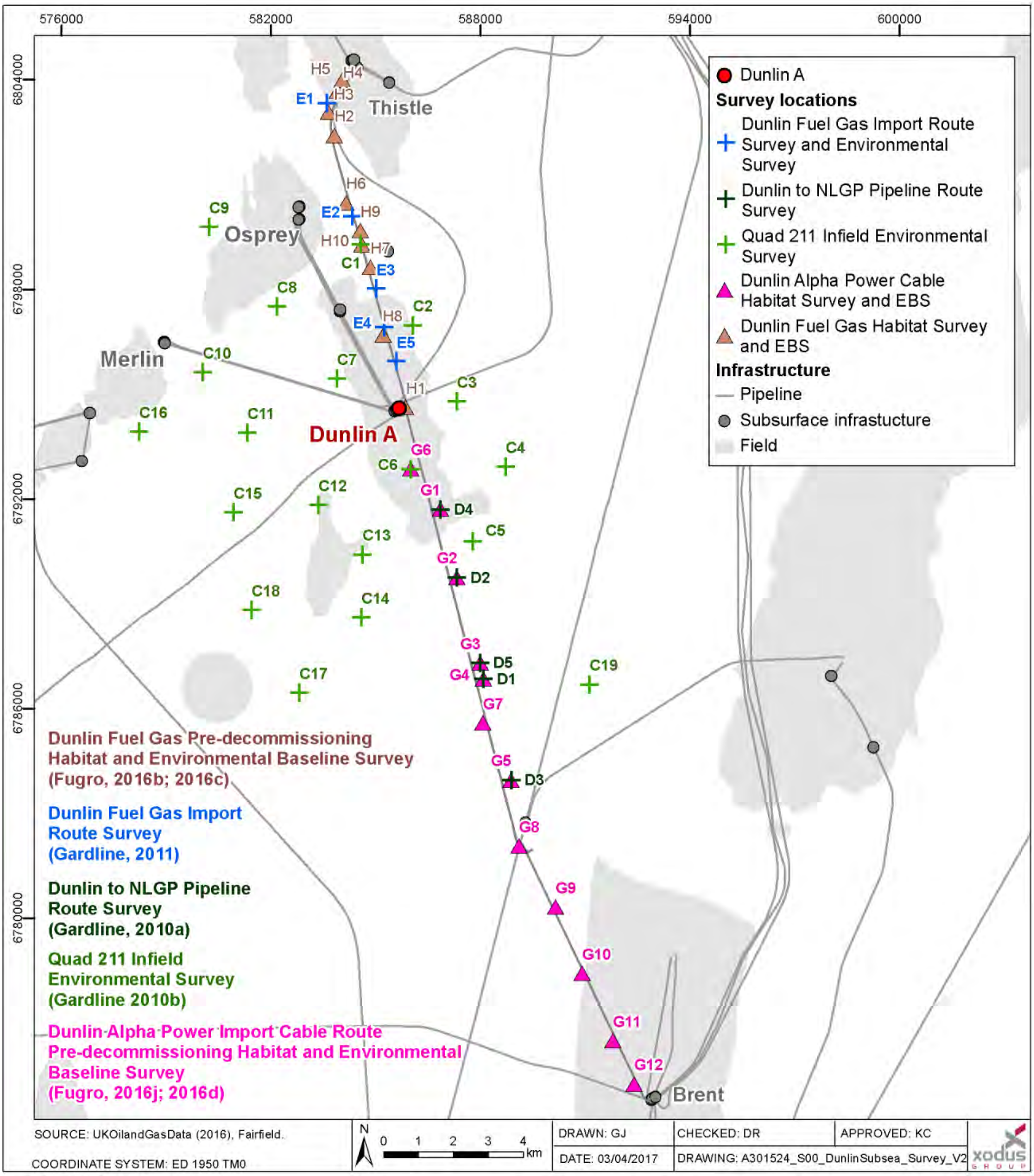


Figure 4.3 Wider Area Survey Station Sampling Locations (Gardline, 2011, Fugro, 2016b, Fugro, 2016c, Gardline, 2010a, Fugro, 2016d, Fugro, 2016e and Gardline, 2010b)

4.2.2. Bathymetry and Sediment Type

The natural seabed depth near the Dunlin Alpha installation is approximately 151 m LAT and varies very little (Gardline, 2009b, Fugro, 2016a). The top of the cuttings pile is at approximately 134.5 m LAT (Gardline 2009b).

Sediment particle size data and the results of basic hydrocarbon analysis for three surveys close to the Dunlin Alpha installation are presented in Table 4.1. Fugro (2017) and Gardline (2009) investigated stations close to, but not on the cuttings pile (see Figure 4.3). Fugro (2018) investigated stations located on the cuttings pile and on the top of the CGBS in areas covered by drilling mud and cuttings.

Sediments collected away from the cuttings pile were classified as fine to medium sand under the Wentworth classification (Fugro, 2017, Gardline, 2009). This was consistent with sediments collected from along the Dunlin Fuel Gas Import (DFGI) pipeline and Dunlin Power Import (DPI) cable route and in the wider Quadrant 211 area (Fugro, 2016c, Fugro 2016e, Gardline, 2010b). Sediment type close to the installation did not appear to be correlated with water depth; this was corroborated by the pipeline and cable route surveys, where no clear gradient was identified (Fugro, 2016c, Fugro 2016e).

Sediments in the cuttings pile and on top of the CGBS were generally finer, with coarse silt recorded at most stations, although coarse sand, medium sand and very fine sand were also recorded (Fugro, 2018). The generally finer sediment at the cuttings pile is consistent with the presence of drilling mud.

4.2.3. Sediment Hydrocarbon and Metal Content

Sediment Total Organic Carbon (TOC) at stations away from the cuttings pile was low, ranging from <0.2% to 0.5% along the DFGI pipeline route (Fugro, 2016c), from <0.2% to 0.45% along the DPI cable route (Fugro, 2016e) and from 0.5% to 1% in the wider Quadrant 211 area (Gardline, 2010b). Results were similar in the vicinity of the Dunlin Alpha installation, ranging from <0.2% to 0.8% (Fugro, 2017, Gardline, 2009) (Table 4.1).

Around the cuttings pile and on the cell tops TOC in surface samples was clearly elevated; of the 15 stations sampled in Fugro (2018) all surface samples but one had TOC >1% with a maximum of 3.11% recorded at Station DCP05 (Table 4.1). Core samples from within the cuttings were collected at Stations DCP01, DCP02, DCP05 and DCP09 on the cuttings pile and at Stations Cell Top 1, Cell Top 2 and Cell Top 3 (Table 4.2). TOC in the sub-surface samples was inconsistent, at some stations TOC decreased with increasing core depth and at some stations it increased. At Station DCP01 TOC was elevated at 50 cm depth compared to the surface sample, but had reduced to below the limit of detection (LoD) at 100 cm. At Station DCP05 TOC was lower at 50 cm than at the surface, but then increased again at 100 cm depth. Below 150 cm depth TOC was at background levels in all the cuttings pile cores. In the Cell Top 1 and Cell Top 2 cores TOC was high at all depths, and higher at 37 cm core depth than at the surface. In Cell Top 3 however, TOC fell to background levels at 17.5 cm core depth. The maximum TOC in the core samples was 8.52%, recorded from Cell Top 1 at 35 cm depth. This result was much higher than any of the surface sample results. There is a clear increase in TOC with increased proximity to the cuttings pile, but the core samples are difficult to interpret as TOC appears to vary widely and inconsistently with core sample depth.

THC showed a similar pattern to TOC, with THC along the DFGI pipeline and DPI cable routes mostly falling between 8.0 μgg^{-1} to 22.9 μgg^{-1} with one outlying result of 170 μgg^{-1} close to the Dunlin Alpha installation (Gardline, 2011, Fugro, 2016c, Gardline, 2010a, Fugro, 2016e). THC in the wider Quadrant 211 area ranged from 10.4 μgg^{-1} to 20.4 μgg^{-1} (Gardline, 2010b).

THC at stations close to, but not on the cuttings pile ranged from 14.7 µgg^{-1} to 317 µgg^{-1} (Fugro, 2017, Gardline, 2009) (Table 4.1), with higher results recorded at stations to the east and south-southeast of the cuttings pile.

THC in sediments taken from the cuttings pile and the cell tops was elevated, ranging from 300 µgg^{-1} at Station DCP08 at the periphery of the pile to 146,000 µgg^{-1} at Station DCP05 located halfway between the edge of the CGBS and the edge of the cuttings pile (Fugro, 2018) (Table 4.1). The result at Station DCP05 was unusually high; THC at the majority of cuttings pile stations was between 1,260 µgg^{-1} and 6,120 µgg^{-1}. THC in the cell top samples was consistently high, ranging from 16,100 µgg^{-1} to 73,400 µgg^{-1}. THC in the cuttings pile core samples generally reduced with depth, although the extent of the reduction varied. At Station DCP01 THC was 38,500 µgg^{-1} at 50 cm depth, much higher than the 1,440 µgg^{-1} recorded at the surface. It then reduced again to 13.7 µgg^{-1} at 100 cm depth. At Station DCP05 THC at 50 cm was 20,600 µgg^{-1}, much lower than the recorded surface concentration of 146,000 µgg^{-1}. At 150 cm however, the concentration rose again to 114,000 µgg^{-1} before reducing to 4,720 µgg^{-1} at 150 cm and 152 µgg^{-1} at 200 cm. In the Cell Top samples, THC was elevated at all depths, although once again there was no clear gradient.

Table 4.1 Surface Sediment Particle Size and Hydrocarbon Data from Site Surveys (Fugro, 2017, Fugro, 2018, Gardline, 2009)

Survey	Station	Sorting	Mean particle size			Total organic carbon (%)	Total hydrocarbon content (µgg^{-1})
			Phi	µm	Wentworth class		
Fugro (2017) located close to the cuttings pile	DFC01	Very poor	2.16	223	Fine sand	0.33	14.7
	DFC02	Very poor	2.15	226	Fine sand	0.30	30.9
	DFC03	Poor	2.20	218	Fine sand	0.26	20.2
	DFC04	Very poor	1.66	316	Medium sand	0.35	102
	DFC05	Poor	1.98	254	Medium sand	<0.20	317
	DFC06	Poor	2.41	189	Fine sand	0.27	18.3
	DFC07	Very poor	2.10	233	Fine sand	0.34	16.4
	DFC08	Very poor	1.88	272	Medium sand	0.27	18.8
	DFC09	Poor	2.15	225	Fine sand	0.27	13.8
	DFC10	Very poor	2.35	196	Fine sand	0.33	73.8
Gardline (2009) located close to the cuttings pile	B1	Poor	1.93	262	Medium sand	0.8	26.8
	B2	Poor	2.03	244	Fine sand	0.8	62.6
	B3	Poor	2.57	168	Fine sand	0.8	136.1
	B4	Very poor	1.97	255	Medium sand	0.8	97.2
	B5	Poor	1.86	276	Medium sand	0.7	104.8
	B6	Very poor	1.89	270	Medium sand	0.7	48.5
	B7	Poor	2.12	230	Fine sand	0.7	43.8
	B8	Poor	2.46	182	Fine sand	0.8	33.3
Fugro (2018) located on the cuttings pile	DCP01	Extremely poor	5.1	29	Medium sand	2.07	1,440
	DCP02	Extremely poor	3.1	117	Very fine sand	2.05	2,930
	DCP03	Extremely poor	4.83	35	Coarse silt	1.49	3,400
	DCP04	Extremely poor	5.04	30	Medium silt	1.70	2,610

Survey	Station	Sorting	Mean particle size			Total organic carbon (%)	Total hydrocarbon content (μgg^{-1})
			Phi	μm	Wentworth class		
	DCP05	Extremely poor	4.85	35	Coarse silt	3.11	146,000
	DCP06	Extremely poor	4.32	50	Coarse silt	1.49	2,170
	DCP07	Extremely poor	4.55	43	Coarse silt	1.33	1,990
	DCP08	Very poor	0.13	912	Coarse sand	<0.20	300
	DCP09	Extremely poor	4.37	48	Coarse silt	1.19	1,820
	DCP10	Very poor	4.25	53	Coarse silt	1.07	2,850
	DCP11	Very poor	4.87	34	Coarse silt	1.74	1,260
	DCP12	Extremely poor	4.26	52	Coarse silt	1.85	6,120
	Cell Top 1	Extremely poor	4.96	32	Coarse silt	2.64	73,400
	Cell Top 2	Very poor	4.76	37	Coarse silt	1.30	37,600
	Cell Top 3	Extremely poor	4.71	38	Coarse silt	1.58	16,100

Table 4.2 Cuttings Pile and Cell Top Core Sample Hydrocarbon Analysis (Fugro, 2018)

Station	Core depth (cm)	Total organic carbon (%)	Total hydrocarbon content (μgg^{-1})	Station	Core depth (cm)	Total organic carbon (%)	Total hydrocarbon content (μgg^{-1})
DCP01	50	2.40	38,500	DCP09	50	1.53	24,500
	100	<0.20	13.7		100	0.23	54.2
	150	<0.20	6.7		150	0.23	60.7
	200	0.33	14.6		200	<0.20	6.3
	250	0.29	14.3		250	0.45	19.5
	300	0.33	11.9		300	0.45	44.7
	380	0.49	28.1	Cell Top 1	0	1.66	73,400
DCP02	23.5	1.46	37,400		35	8.52	24,800
	47	7.59	46,700		70	2.45	35,100
DCP05	50	1.41	20,600	Cell Top 2	0	2.32	37,600
	100	5.11	114,000		35	4.99	73,400
	150	0.26	4,720		72.5	2.15	49,200
	200	0.37	152	Cell Top 3	0	1.53	16,100
	250	0.26	79.6		17.5	0.23	48,400
	300	0.46	31.5		35	0.23	31,100
	350	0.44	18.0	-			

Table 4.3 presents the mean concentrations of THC and several heavy metals recorded in the three Dunlin surveys discussed above, as well as the Quad 211 infield survey which sampled the wider Quadrant 211 area (Gardline, 2010b), the OSPAR (2005) background concentrations and United Kingdom Offshore Operators

Association (UKOOA) (2001) mean and 95th percentile concentrations for stations >5 km from an active platform and stations within 500 m of an active platform in the northern North Sea.

The mean THC from the Quad 211 infield survey (Gardline, 2010b) was between the UKOOA (2001) mean and 95th percentile values for stations >5 km from an active installation, indicating the background THC in Quad 211 is similar to other undisturbed areas of the northern North Sea. The THC recorded is likely to be a combination of naturally occurring and highly weathered anthropogenic hydrocarbons from distant diffuse sources (Gardline, 2010b).

Compared to the Gardline (2010b) result, the mean THC from the two surveys conducted close to the cuttings pile but not actually on it showed slightly elevated THC, although mean THC was still within one order of magnitude of the UKOOA (2001) values. The slightly elevated THC levels recorded in these two surveys are likely due to small amounts of diesel from the diesel based drilling fluids historically used at the Dunlin Alpha installation.

On the cuttings pile and the cell tops, THC was clearly and consistently elevated well above UKOOA (2001) 95th percentile levels for the northern North Sea and in line with the average concentration for sediments within 500 m of active platforms in the wider North Sea (11,049 $\mu g g^{-1}$ – data specific to the northern North Sea was unavailable for this parameter). The elevated THC levels recorded are consistent with legacy contamination with non-aqueous drilling fluids, and Fugro (2018) identifies signatures of four separate drilling fluids within the sediment samples.

Heavy metal concentrations were consistent with the THC results. The mean heavy metal concentrations from Gardline (2010b) were in line with UKOOA (2001) mean concentrations for stations more than 5 km from an active installation, and were below the OSPAR (2005) background concentrations. Heavy metals at stations close to the cuttings pile were present at close to OSPAR (2005) and UKOOA (2001) background concentrations, although most were slightly elevated, notably barium, which is indicative of the presence of drilling mud.

On the cuttings pile concentrations of most heavy metals were much higher than background concentrations. Barium in the form of barium sulphite (barite) is a common weighting agent in drilling muds and often contains other trace elements as impurities, including cadmium, chromium, copper, lead, mercury and zinc. The elevated concentrations in the cuttings pile sediments are therefore consistent with the presence of drilling mud, while the slightly elevated levels in the surrounding sediments likely represent settling and re-settling of small quantities of drilling mud and cuttings away from the main pile.

Table 4.3 Comparison of Contaminants from Dunlin Surveys with North Sea Background Concentrations

Survey	Average concentration (μgg^{-1} dry sediment)							
	THC	Barium	Chromium	Copper	Cadmium	Nickel	Lead	Zinc
Fugro, 2017 (near cuttings pile)	62.6	2,043	18	17.3	0.083	6.87	20.3	97.1
Gardline, 2009b (near cuttings pile)	69.1	3,975	18	10.7	0.12	6.7	21	68
Fugro, 2018 (on cuttings pile / cell tops)	14,400	34,412	82.8	155	1.78	41.3	79.1	1,565
Gardline, 2010b (Quad 211 infield survey)	16.9	478	14	3.2	0.06	6.4	8.8	8
OSPAR (2005) background concentrations	-	-	60	20	0.2	30	25	90
UKOOA mean concentration[8] for stations >5 km from an active platform (UKOOA, 2001)	10.82	332	17.1	3.6	-	10.9	7	12.1
UKOOA 95th percentile concentrations for stations >5 km from an active platform (UKOOA, 2001)	20.32	637	36.5	5.4	-	12.4	8.6	13
UKOOA mean concentrations for stations 0 - 500 m from an active platform) (UKOOA, 2001)[9]	-	29,600	55.1	-	0.53	-	36.4	-

Organotin compounds, principally tributyltin (TBT), were historically used in marine antifouling products. TBT accounted for almost all of the organotin compounds present in the surface samples collected from the Dunlin Alpha cuttings pile. Where measurable quantities were recorded, the values were higher than the EAC thresholds set by OSPAR. Dibutlytin (DBT) was the principle organotin compound recorded in the subsurface 'core' samples. This may indicate that microbial degradation of the TBT is occurring in the Dunlin Alpha drill cuttings pile. TBT levels ranged from a minimum of <0.4 ngg^{-1} at Station DCP02 and DCP05 to a maximum of 20.1 ngg^{-1} at Station DCP07. The mean across survey stations was 4.8 ngg^{-1}. Total organotins ranged from < 0.4 ngg^{-1} to a maximum of 20.1 ngg^{-1}, averaging 5.0 ngg^{-1} across stations (Fugro, 2018).

4.3. Biological Environment

4.3.1. Benthos

4.3.1.1. Around the Dunlin Alpha Installation

The area surrounding the cuttings pile has been investigated by recent surveys, Gardline (2009) and Fugro (2017b). In both surveys the macrofauna was dominated by annelids, and the most common taxon was the polychaete *Galathowenia oculata*, which accounted for 5% of individuals identified in Gardline (2009) and 18% in Fugro (2017). *G. oculata* is considered to be a hydrocarbon intolerant species, as is *Euchone incolor*, another polychaete that was abundant in Fugro (2017), although *G. oculata* has been found at increased densities in disturbed or organically enriched environments (Gardline, 2009). *Paramphinome jeffreysii*, considered to be a hydrocarbon tolerant species, was common but not dominant in Fugro (2017), the moderate dominance of *G. oculata*, reported in Fugro (2017) (but not in Gardline, 2009) may indicate the slightly elevated TOC in the vicinity of the Dunlin Alpha installation is having a slight effect on community structure, although the survey

[8] Mean concentrations for metals in sediments >5 km from nearest platform for the northern North Sea.
[9] Mean concentrations for metals in sediments 0 – 500 m from nearest platform for the northern North Sea.

area was found overall to be species rich, diverse and homogenous (Gardline, 2009, Fugro, 2017). Six of the ten most dominant taxa reported in Gardline (2009) were also reported in comparison surveys from the surrounding area, indicating the abundances recorded in Gardline (2009) are not unusual for the region.

Observed epifauna was sparse and included starfish (Asteroidea), sea anemones (Actiniaria including *Cerianthus lloydii*), sea urchins (Echinoidea), sponges (Porifera) and gastropods (Gastropoda) (Fugro, 2016a).

Fugro (2017) reported that a previous habitat assessment (Fugro, 2016a) had identified the area around the Dunlin Alpha installation as the EUNIS biotope complex ‘Circalittoral muddy sand’ (A.26), but that the macrofauna present did not match any of the classifications within this complex. Fugro (2017) suggested the habitat in the area was a variation on European Nature Information System (EUNIS) habitat A5.253 (medium to very fine sand, 100 m to 120 m, with polychaetes *Spiophanes kroyeri*, *Amphictene auricoma*, *Myriochele* sp. (*Galathowenia* sp.), *Aricidea wassi* and amphipods *Harpinia antennaria*). A still taken at Station DFC01 is presented in Figure 4.4.

Figure 4.4 Seabed in the Vicinity of the Dunlin Alpha Installation, Showing Fine Sand (Fugro, 2016a)

No evidence of Annex I habitats or species was reported in Gardline (2009). Fugro (2017) reported small numbers of juvenile *Arctica islandica*, a bivalve that is on the OSPAR (2008) ‘List of threatened and declining habitats and species’ and is a Priority Marine Feature for which Scottish marine protected areas (MPAs) may be selected. The small numbers of juveniles reported are not expected to qualify the area as a potential protected site.

Surveys in the wider area, DFGI pipeline route (Fugro, 2016b, Fugro, 2016c, Gardline 2011), DPI cable route (Fugro, 2016d, Fugro, 2016e, Gardline, 2010a) and Quad 211 infield survey (Gardline, 2010b) indicated the macrofauna was not affected by anthropogenic disturbance. Macrofauna was broadly uniform with some small-scale variability (Fugro, 2016c). The number of taxa was high, and stations were not strongly dominated by single taxa. Many taxa were found at low abundances, which combined with a high overall taxa count, indicates a well-balanced, undisturbed community.

4.3.1.2. Cuttings Pile

The benthos on the cuttings pile was investigated by Fugro (2018). In contrast to Gardline (2009) and Fugro (2017), the macrofauna on the cuttings pile was found to be dominated by hydrocarbon tolerant taxa including *Capitella* sp. and *Thyasira sarsi*, and secondary colonisers including *Chaetozone setosa* and *Cirratulus cerratus*. The cuttings pile supported fewer taxa than the surrounding area, but higher numbers of individuals, suggesting super-abundance of disturbance tolerant taxa. The single most common taxon at each station accounted for between 33.5% and 84.2% of individuals at each station, indicating a high degree of numerical dominance (Fugro, 2018). Several taxa that were abundant in the surrounding area, including *G. oculata*, *E. incolor*, *Paradoneis lyra*, *P. jeffreysii*, *Amythasides macroglossus*, *Pterolysippe vanelli* and the bivalve *Axinulus croulinensis*, were noted to be absent from the survey area or present in low numbers (Fugro 2018). Diversity and evenness values were low to moderate, reflecting the low number of taxa and the high abundance of the dominant taxa.

Statistical analysis showed that increased distance from the Dunlin Alpha installation correlated negatively with number of individuals and positively with number of taxa and diversity and evenness indices. This indicates that the community is more heavily modified closer to the Dunlin Alpha installation.

The predominant biotope identified across the cuttings is broadly similar to EUNIS habitat A5.374 '*Capitella* sp. and *Thyasira* spp. in organically enriched offshore circalittoral mud and sandy mud' (Fugro, 2018). A still taken at Station DCP05 is presented in Figure 4.5.

While the infauna on the cuttings pile was impoverished, the various sediment types and the anthropogenic debris present on the surface afforded a variety of habitats for epifauna. The sediment was interspersed with mussel shell fragments, mussel beds, and possible bacterial mats of *Beggiatoa* spp. The reef forming cold water coral *Lophelia pertusa* was observed, as well as the IUCN listed ling (*Molva molva*) and possibly listed redfish (*Sebastes* sp.). Potentially sensitive habitats included mussel beds and *Beggiatoa* spp. on anoxic sublittoral sediment. Given that these habitats are present due to the artificial conditions on the cuttings pile they are not expected to qualify for protected status.

Figure 4.5 Dunlin Cuttings Pile Seabed Photography, Showing Muddy Sand with Mussel Shells and a Starfish (Asteroidea sp.) (Fugro, 2016a)

Overall, the fauna close to but not on the cuttings piles was similar to that observed at undisturbed locations remote from the Dunlin Alpha installation. There was a possibility of slight community modification due to organic enrichment, but the community was found to be species rich, diverse and homogenous (Gardline, 2009b, Fugro, 2018). The benthic community on the cuttings pile itself was highly modified and dominated by hydrocarbon tolerant species. The community was species poor, with less diversity and less evenness (Fugro, 2018). The observed diversity of epifauna was higher on the cuttings pile due to the increased number of habitats available (higher variety of sediment grain sizes compared to undisturbed seabed and anthropogenic debris providing hard surfaces for attaching species).

4.3.2. Fish and Shellfish

DECC (2016) report that species diversity within the fish community is not as great in the central and northern North Sea as in the southern North Sea. DECC (2016) also report that the fish community between 100 and 200 m (i.e. within the depth bounds of the Project area) is characterised by long rough dab (*Hippoglossoides platessoides*), hagfish (*Myxine glutinosa*) and Norway pout (*Trisopterus esmarkii*). Basking shark (*Cetorhinus maximus*), tope (*Galeorhinus galeus*) and porbeagle (*Lamna nasus*) are all also likely to occur in small numbers throughout the North Sea, and the common skate (*Dipturus batis*) occurs at low density throughout the northern North Sea. However, these species are considered to be rare in the waters surrounding the Project area (DECC, 2016). The fish populations in the Project area are characterised by species typical of the northern North Sea. There are a number of spawning and nursery regions for commercially important fish and shellfish species that occur in the vicinity of the Project area (Coull *et al*., 1998, Ellis *et al*., 2012). The Project area is located within the spawning grounds of haddock (*Melanogrammus aeglefinus*), saithe (*Pollachius virens*), Norway pout (*Trisopterus esmarkii*), cod (*Gadus morhua*) and whiting (*Merlangius merlangus*) and the nursery grounds of haddock, Norway pout, mackerel (*Scomber scombrus*), blue whiting (*Micromesistius poutassou*), spurdog (*Squalus acanthias*), herring (*Clupea harengus*) and ling (*Molva molva*). Information on spawning and nursery seasonality for the different species is detailed in Table 4.4 and the extent of the areas is illustrated in Figure 4.6 and Figure 4.7.

Table 4.4 Fish Spawning and Nursery Timings in the Project Area (Coull *et al*., 1998, Ellis *et al*., 2012)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Haddock	N	SN	SN	SN	SN	N	N	N	N	N	N	N
Saithe	S	S	S	S								
Norway pout	SN	SN	SN	SN	N	N	N	N	N	N	N	N
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Blue whiting	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog	N	N	N	N	N	N	N	N	N	N	N	N
Herring	N	N	N	N	N	N	N	N	N	N	N	N
Cod	S	S	S	S								
Whiting		S	S	S	S	S						
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Key	S = Peak spawning			S = Spawning			N = Nursery					

Fisheries sensitivity maps produced by Aires *et al*. (2014), indicate that there is a low probability of aggregations of Group 0 fish (fish in their first year of life) occurring in the Project area for all species investigated.

The pre-decommissioning habitat assessment survey of the Dunlin field recorded ling, redfish (*Sebastes* sp.), unidentified cod-like fish (*Gadiformes* sp.), saithe and haddock (Fugro, 2016a).

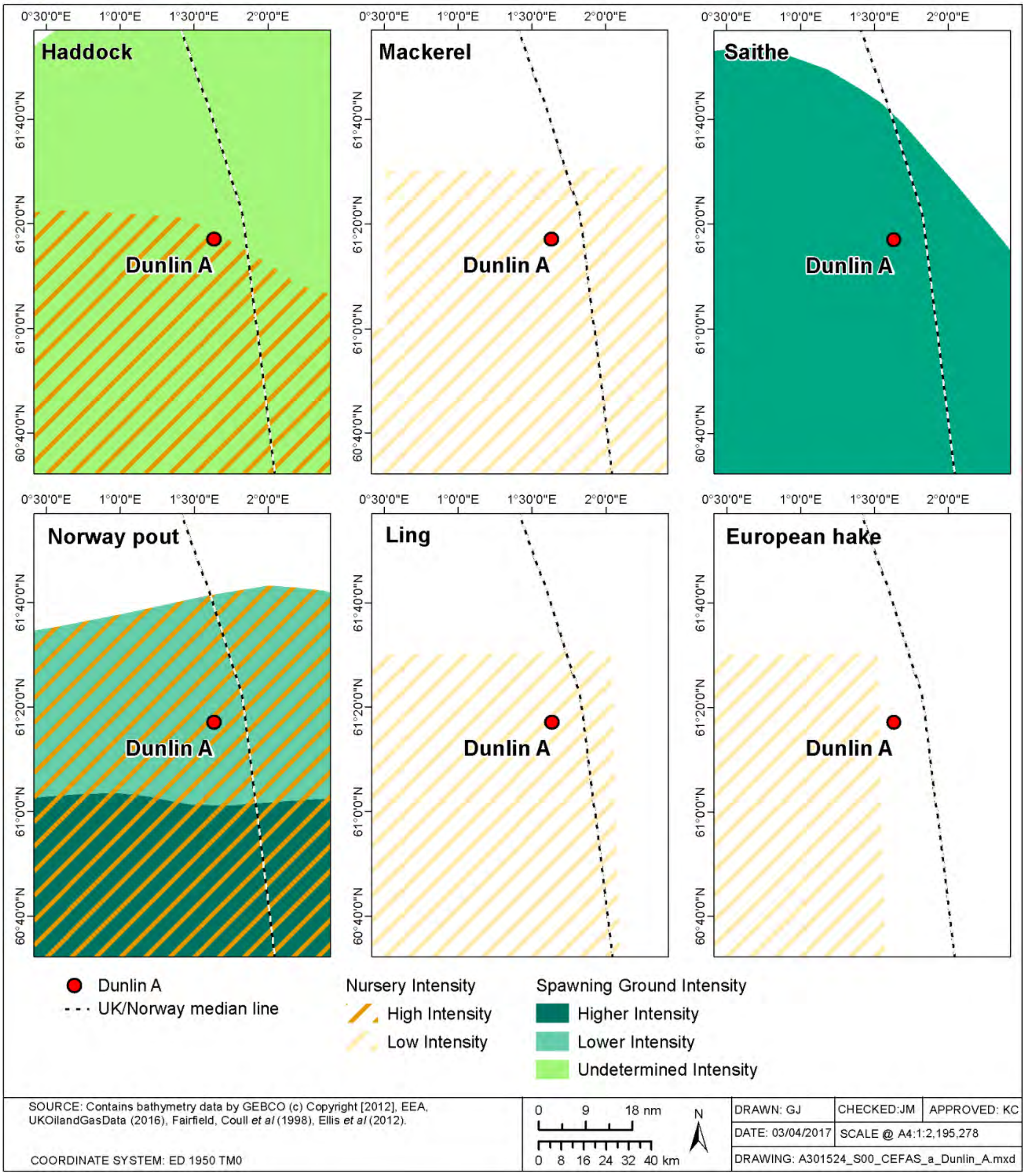


Figure 4.6 Fish Spawning and Nursery Grounds Around the Project area (Coull *et al*., 1998, Ellis *et al*., 2012)

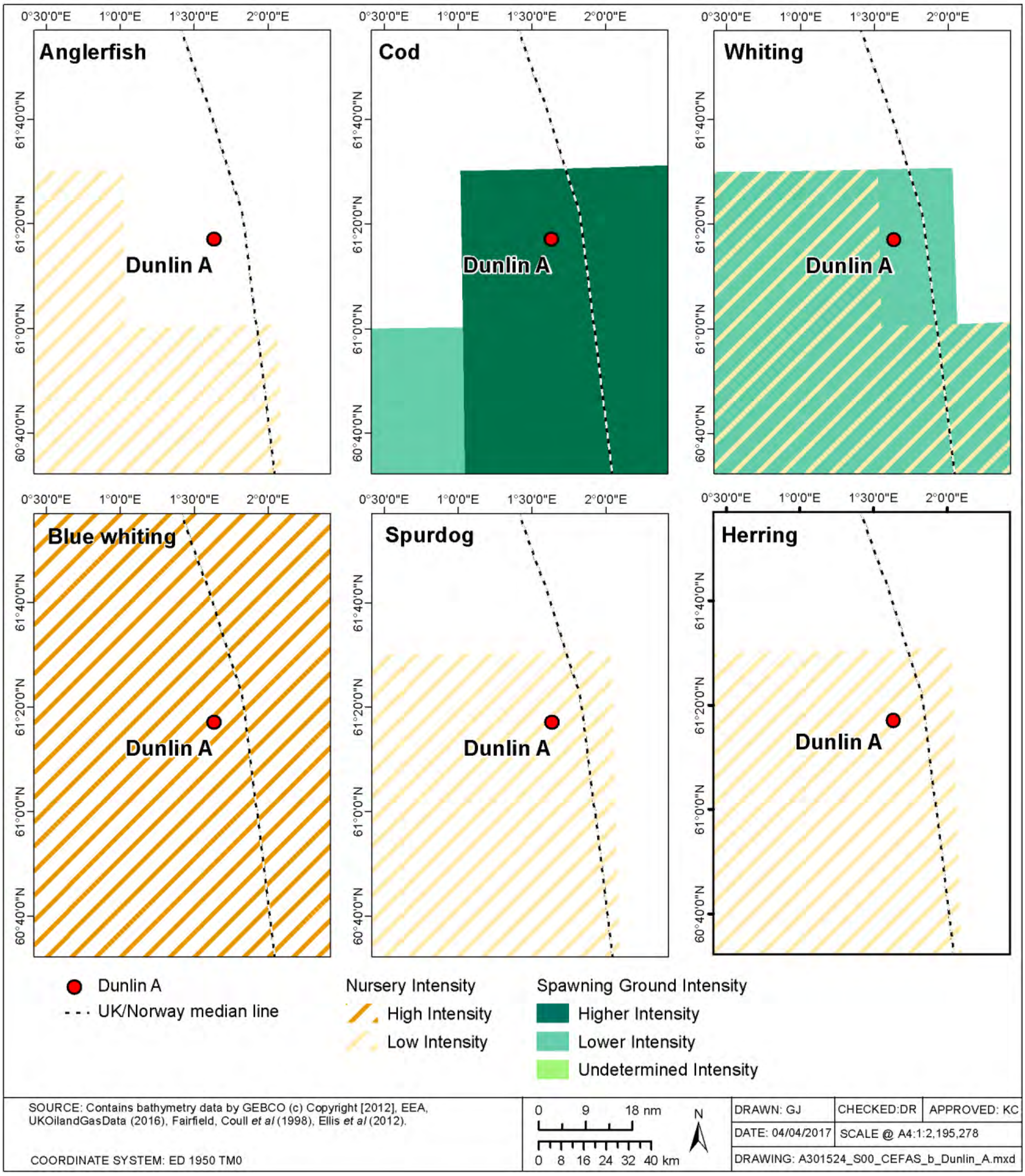


Figure 4.7 Fish Spawning and Nursery Grounds Around the Project Area (Coull *et al*., 1998, Ellis *et al*., 2012)

4.3.3. Seabirds

The Project area is important for northern fulmar (*Fulmarus glacialis*), northern gannet (*Morus bassanus*), great black-backed gull (*Larus marinus*), Atlantic puffin (*Fratercula arctica*), black-legged kittiwake (*Rissa tridactyla*), and common guillemot (*Uria aalge*) for the majority of the year (DECC, 2016). Manx shearwaters (*Puffinus puffinus*) are present in the vicinity of the Project area between spring and autumn months. European storm petrels (*Hydrobates pelagicus*) are present during September and November. Great skua (*Stercorarius skua*), glaucous gull (*Larus hyperboreus*), Arctic skua (*Stercorarius parasiticus*) and little auk (*Alle alle*) are generally present in the northern North Sea in low densities for the majority of the year.

The seasonal sensitivity of seabirds to oil pollution in the immediate vicinity of the Project area has been derived from the JNCC Seabird Oil Sensitivity Index (SOSI) (Hi Def, 2016), and is presented in Table 4.5, Figure 4.8 and Figure 4.9.

Table 4.5 Seabird Sensitivity to Oil Pollution in the Project Area (Hi Def, 2016)

Block	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
211/17	3	5	5	5	N	5	5	5	5	N	3	3
211/18	3	5	5	5	N	5	5	5	5	N	3	3
211/19	3	5	5	5	N	5	5	5	5	N	3	3
211/22	5	5	5	5	N	5	5	5	4	4	4	4
211/23	5	5	5	5	N	5	5	5	5	5	3	3
211/24	5	5	5	5	N	5	5	5	5	5	3	3
211/27	5	5	5	5	N	5	5	5	4	4	5	5
211/28	5	5	5	5	N	5	5	5	4	4	5	5
211/29	5	5	5	5	N	5	5	5	5	5	5	5

Key	Data taken from adjoining months	Data taken from adjoining blocks	No data available

1= Extremely high, 2= Very high, 3 = High, 4= Medium, 5 = Low

The data indicates that seabirds are most vulnerable to oil pollution in December, with the lack of data for November leading to a presumption of raised sensitivity in November too. Overall vulnerability is low.

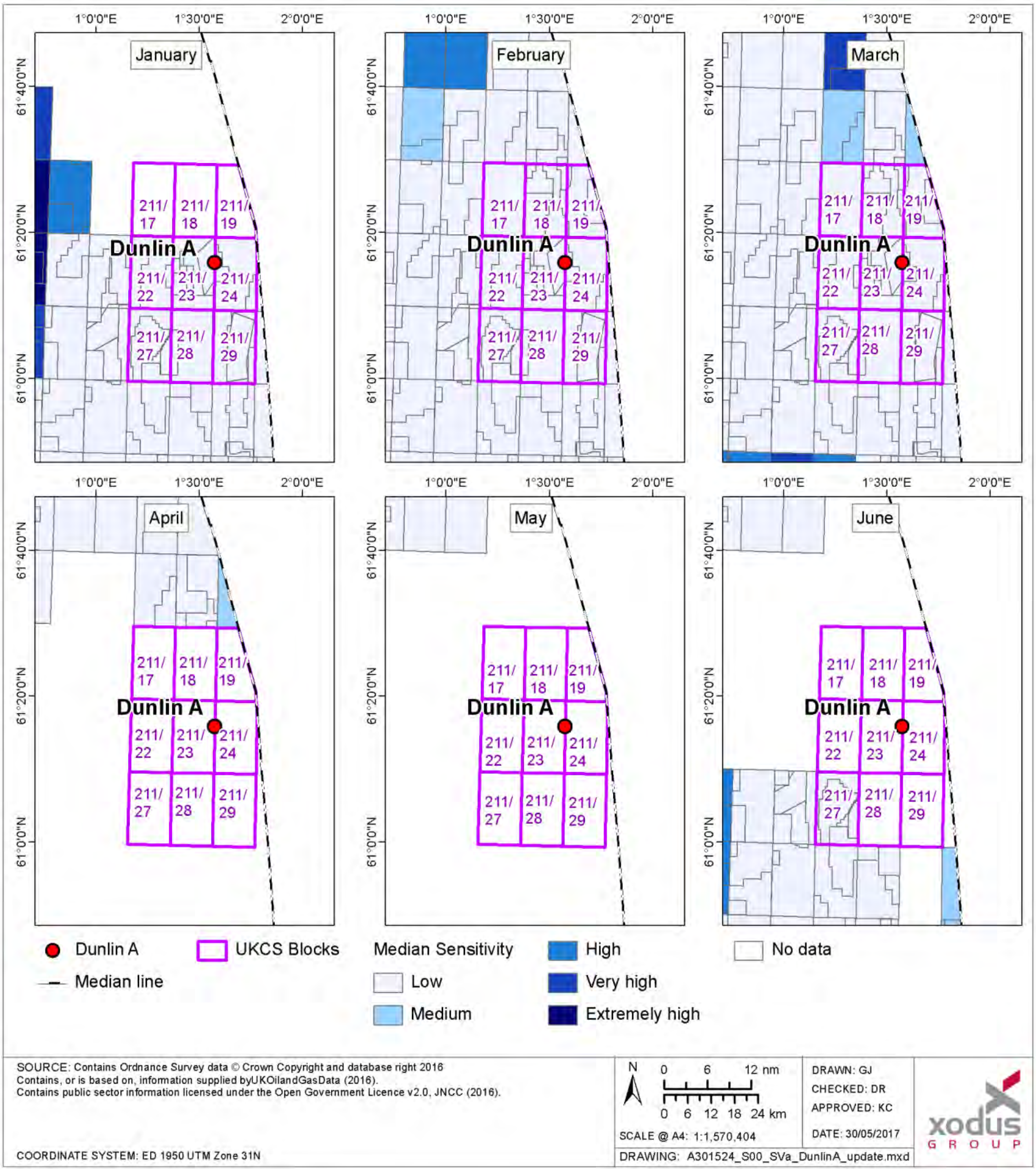


Figure 4.8 Seabird Vulnerability in the Vicinity of the Project Area (Hi Def, 2016)

Figure 4.9 Seabird Vulnerability Within the Vicinity of the Project Area (Hi Def, 2016)

There are significant data gaps at times of the year for the Project area (Hi Def, 2016), with data missing for some blocks in seven months. The JNCC (1999) seabird vulnerability index presents older data, but has more comprehensive coverage of the Project area. Seabird vulnerability according to JNCC (1999) is presented in Figure 4.10 and Figure 4.11. The months of March, July, October and November are those when seabird species at the Project area is recorded as most vulnerable to surface pollution, which does not correlate well with the Hi Def (2016) data, except for the period of presumed elevated sensitivity in November. Overall annual seabird vulnerability according to JNCC (1999) is predicted to be slightly higher than that predicted in Hi Def (2016), with moderate, high or very high vulnerability reported in eight out of twelve months in JNCC (1999), compared to two months (including one month where proxy data is recorded) in Hi Def (2016).

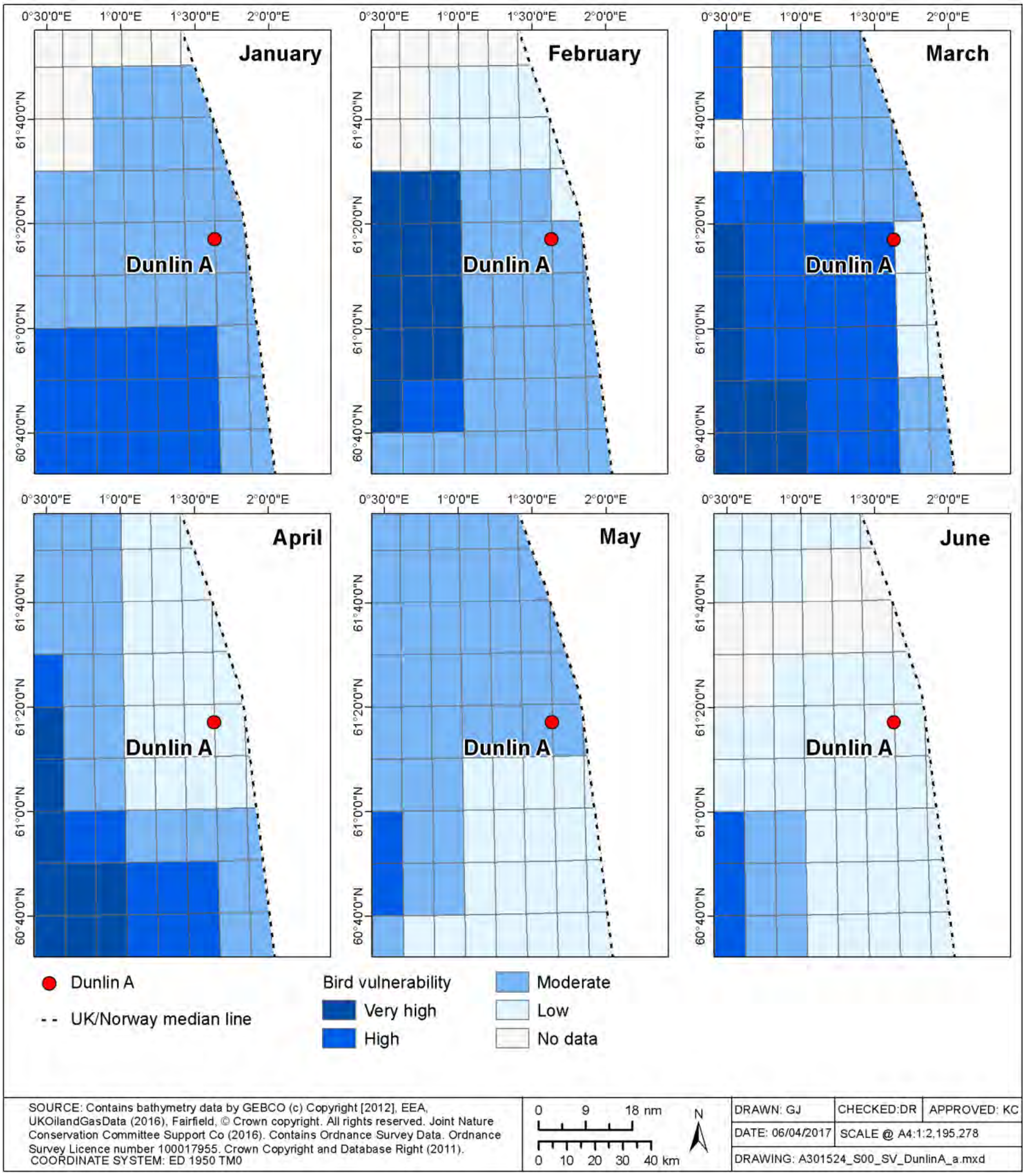


Figure 4.10 Seabird Vulnerability in the Vicinity of the Project Area (JNCC, 1999)

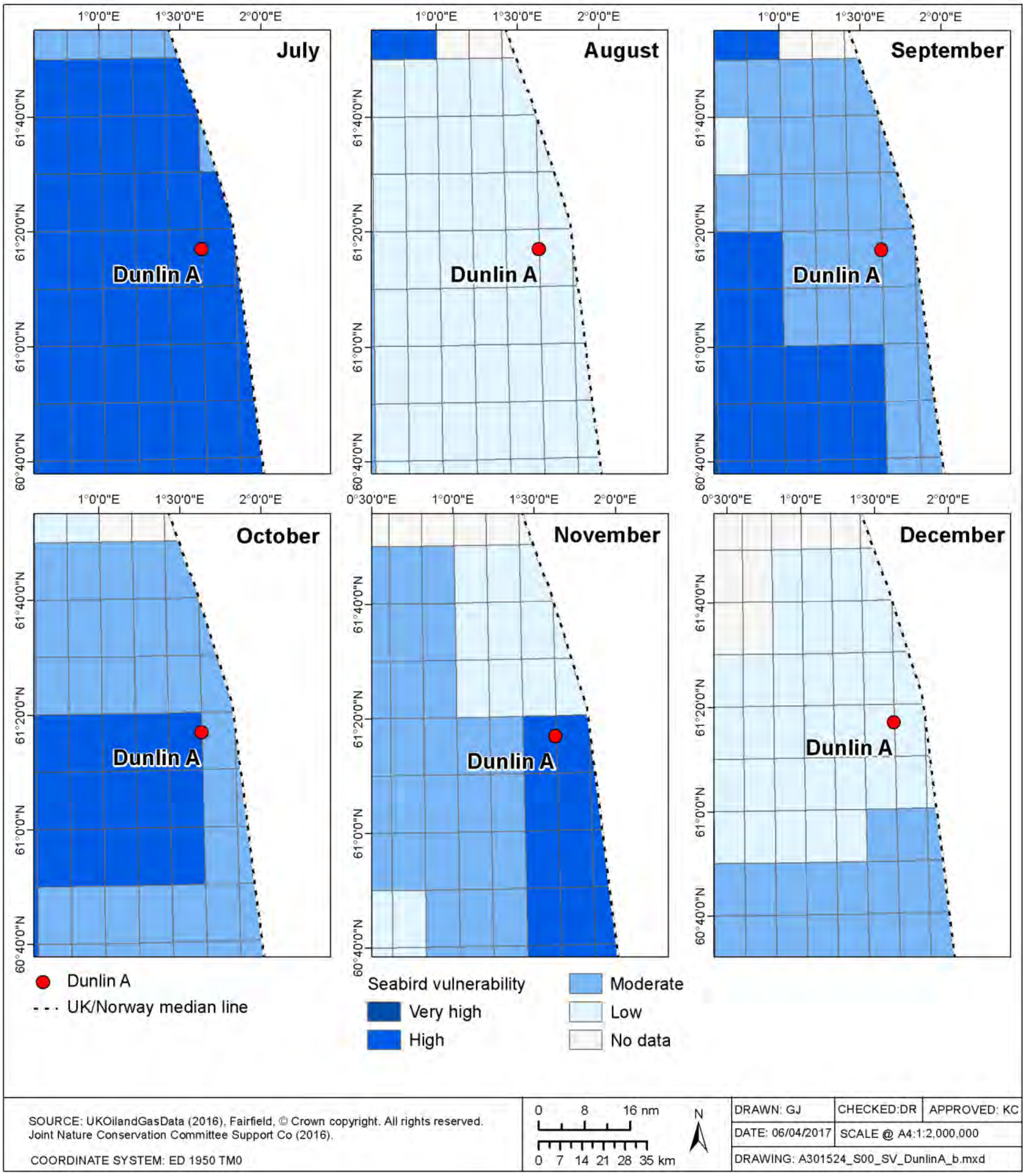


Figure 4.11 Seabird Vulnerability Within the Vicinity of the Project Area (JNCC, 1999)

4.3.4. Cetaceans

Twenty-eight cetacean species have been recorded in UK waters from sightings and strandings. Of these, eleven species are known to occur regularly, while seventeen are considered rare or vagrant (DECC, 2016). Cetaceans regularly recorded in the North Sea include white-sided dolphin (*Lagenorhynchus acutus*), bottlenose dolphin (*Tursiops truncatus*) (primarily in inshore waters), harbour porpoise (*Phocoena phocoena*), killer whale (*Orcinus orca*), minke whale (*Balaenoptera acutorostrata*), pilot whale (*Globicephala melas*), common dolphin (*Delphinus delphis*) and white-beaked dolphin (*Lagenorhynchus albirostris*) (Reid *et* al., 2003). Risso's dolphin (*Grampus griseus*) and some large baleen whales are also occasionally sighted. Spatially and temporally, harbour porpoise, white-beaked dolphins, minke whales, killer whales and Atlantic white-sided dolphins are the most regularly sighted cetacean species in the North Sea (Hammond *et al*., 2001, Reid *et al*., 2003). The bottlenose dolphin is generally coastal in extent and thus is unlikely to be sighted in the vicinity of the Project area with any regularity.

Occurrence of the most frequently recorded species is detailed in Table 4.6; the Project area is not considered to be particularly important for any cetacean species.

Table 4.6 Occurrence of Cetaceans Likely to be Most Regularly Observed in the Project Area (Hammond *et al*., 2001, Reid *et al*., 2003, Hammond *et al*., 2017)

Species	Description of occurrence
Harbour porpoise	Harbour porpoise are frequently found throughout the UK waters. They usually occur in groups of one to three individuals in shallow waters, although they have been sighted in larger groups and in deep water. It is not thought that the species migrate.
Killer whale	Widely distributed with sightings across the North Sea all year round; seen in both inshore waters (April to October) and the deeper continental shelf waters (November to March). May move inshore to target seals seasonally.
Minke whale	Minke whales usually occur in water depths of 200 m or less and occur throughout the northern and central North Sea. They are usually sighted in pairs or in solitude; however groups of up to 15 individuals can be sighted feeding. It appears that animals return to the same seasonal feeding grounds.
Atlantic white-sided dolphin	White-sided dolphins show both season and inter-annual variability. They have been sighted in large groups of 10 - 100 individuals. They have been sighted in waters ranging from 100 m to very deep waters, but also enter continental shelf waters. They can be sighted in the deep waters around the north of Scotland throughout the year and enter the North Sea in search of food.
White-beaked dolphin	White-beaked dolphins are usually found in water depths of between 50 and 100 m in groups of around 10 individuals, although large groups of up to 500 animals have been seen. They are present in the UK waters throughout the year, however more sightings have been made between June and October.

4.3.5. Seals

Grey (*Halichoerus grypus*) and harbour (*Phoca vitulina*) seals will feed both in inshore and offshore waters depending on the distribution of their prey, which changes both seasonally and yearly. Both species tend to be concentrated close to shore, particularly during the pupping and moulting season. Seal tracking studies from the Moray Firth have indicated that the foraging movements of harbour seals are generally restricted to within a 40 – 50 km range of their haul-out sites (Special Committee on Seals (SCOS), 2014). The movements of grey seals can involve larger distances than those of the harbour seal, and trips of several hundred km from one haul-out to another have been recorded (Sea Mammal Research Unit (SMRU), 2011). As the Project area is located approximately 137 km offshore, these species may be encountered in the vicinity from time to time, but the Project area is not important for these species. This is confirmed by the latest grey and harbour seal density maps commissioned by the Scottish Government which report the presence of grey and harbour seals in the Project area as between zero and one individual per 25 km^2 (Russell, Jones and Morris, 2017).

4.4. Conservation

There are no designated or proposed sites of conservation interest in the Project area. The closest designated site, the Site of Community Importance (SCI) 'Pobie Bank Reef', lies 98 km to the south west of the Dunlin Alpha installation, off the east coast of Shetland (Figure 4.12). The site has been designated for its stony and bedrock rocky reefs (JNCC, 2013a). The closest SPA is Hermaness, Saxa Vord and Valla Field which lies 137.5 km south west of the Dunlin Alpha installation. The site is designated due to it supporting breeding populations of northern gannet, great skua and Atlantic puffin.

Marine Scotland has put forward areas with Priority Marine Features (PMF) for designation as MPAs under the Marine (Scotland) Act (2010). The Marine Management Organisation (MMO) has put forward areas with features of conservation importance (FOCI) for designation as MCZs under the UK Marine and Coastal Access Act (2009). The closest MPA to the Project area is the North-east Faroe Shetland Channel Nature Conservation MPA (NCMPA). The site is approximately 116.5 km from the project area and is the largest designated MPA in Europe. The site is designated for deep-sea sponge aggregations, offshore deep-sea muds, offshore subtidal sands and gravels, and continental slope (JNCC, 2017). Details of the conservation sites in the vicinity of the Project area are given in Table 4.7.

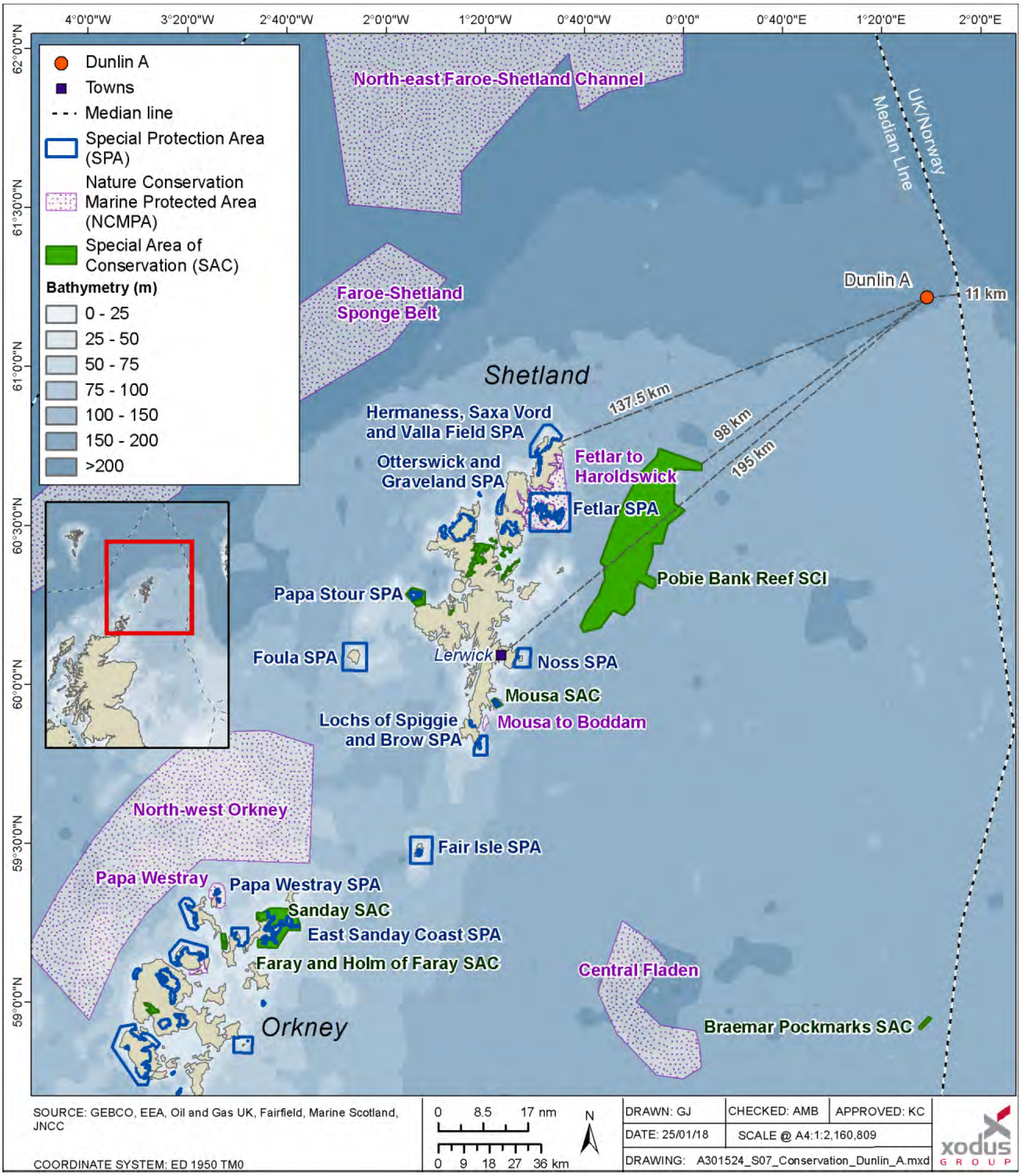


Figure 4.12 Sites of Conservation Importance

Table 4.7 Conservation Sites in the Vicinity of the Project Area

Description	Distance to Project area (km)
Pobie Bank SCI	
Reefs are the primary reason for selection of this site. The stony and bedrock reefs of the site provide a habitat to an extensive community of encrusting and robust sponges and bryozoans and in the shallowest areas the bedrock and boulders also support encrusting coralline algae (JNCC, 2013a).	98
Hermaness, Saxa Vord and Valla Field SPA	
This site supports: A population of European importance of the Annex I species red throated diver (*Gavia stellata*) during the breeding season; Populations of European importance of the following migratory species during the breeding season: northern gannet, great skua and Atlantic puffin; and At least 20,000 seabirds. During the breeding season, the area regularly supports 152,000 individual seabirds including common guillemot, black-legged kittiwake, European shag (*Phalacrocorax aristotelis*), northern fulmar, Atlantic puffin, great skua and northern gannet (JNCC, 2005a).	137.5
North East Faroe Shetland Channel NCMPA	
This is the largest designated MPA in Europe and the protected features are deep sea sponge aggregations, offshore deep sea muds, offshore subtidal sands and gravel, continental slope and a wide range of features from the West Shetland Margin Palaeo-depositional, Miller Slide and Pilot Whale Diapirs that are considered to be 'Key Geodiversity Areas' (JNCC, 2017).	116.5
Faroe-Shetland Sponge Belt NCMPA	
The protected features of this NCMPA are deep sea sponge aggregations, offshore subtidal sands and gravels, ocean quahog aggregations, continental slope, continental slope channels, iceberg plough marks, prograding wedges and slide deposits representative of the West Shetland Margin paleo-depositional system Key Geodiversity Area and Sand wave fields and sediment wave fields representative of the West Shetland Margin contourite deposits Key Geodiversity Area (JNCC, 2016).	169
Fetlar to Haroldswick NCMPA	
This MPA supports a range of high energy habitats and species including horse mussel beds, kelp and seaweed communities and maerl beds. It encompasses over 200 km^2 of important black guillemot (*Cepphus grylle*) feeding grounds. The protected features of the site are black guillemot, circalittoral sand and coarse sediment communities; horse mussel beds, kelp and seaweed communities on sublittoral sediment, maerl beds, shallow tide-swept coarse sands with burrowing bivalves and marine geomorphology of the Scottish shelf seabed (Scottish Natural Heritage (SNH), 2016).	140.5

Description	Distance to Project area (km)
Fetlar SPA	
The SPA comprises a range of habitats including species-rich heathland, marshes and lochans, cliffs and rocky shores. The principal areas of importance for birds are the northernmost part of the island and the south-western peninsula of Lamb Hoga. This site supports: During the breeding season, a population of European importance of Arctic tern (*Sterna paradisaea*) and red-necked phalarope *(Phalaropus lobatus)*; Populations of European importance of the following migratory species during the breeding season: dunlin (*Calidris alpina schinzii*), great skua and whimbrel (*Numenius phaeopus*); and At least 20,000 seabirds. During the breeding season, the area regularly supports 22,000 individual seabirds including Arctic skua, northern fulmar, great skua, Arctic tern and red-necked phalarope (JNCC, 2005b).	143

Survey work undertaken in the Project area has identified several species and habitats of conservation interest, including juvenile *Arctica islandica* (Fugro, 2017), mussel beds and Beggiatoa spp. on anoxic sediment, *Lophelia pertusa*, ling and *Sebastes* spp. (which may be protected depending on the species) (Fugro, 2017). As the juvenile *Arctica islandica* were found in small numbers they are not expected to qualify the area as a potential protected site (Fugro, 2017). The other species and habitats of conservation concern were deemed to be present in the area due to the artificial conditions on the cuttings pile and the infrastructure associated with the development, and are not therefore expected to qualify for protected status (Fugro, 2018).

Lophelia pertusa is known to be present on some of the subsea infrastructure at Dunlin Alpha, including the conductors and the CGBS (e.g. Fugro, 2016a). *Lophelia pertusa* is a reef-building cold water coral that provides habitats for other epifaunal and fish species, and is a UK habitat of principle importance and a Scottish Priority Marine Feature; it is also highlighted in Annex I of the European Habitats Directive, and is on the OSPAR List of Threatened and/or Declining Species and Habitats. This species is normally restricted to deep water in depth ranges of 200 – 2,000 m on the continental slope and the extent of *Lophelia pertusa* reefs is undergoing an overall decline due to mechanical damage by demersal fishing gear in all OSPAR areas (OSPAR, 2009b). However, the species has also been recognised in the scientific literature as one which grows opportunistically on oil and gas subsea infrastructure (e.g. Gass & Roberts, 2006) and which has been recorded from many offshore installations in the northern North Sea at depths between 59 m and 132 m.

The Dunlin Alpha was included in a study by the University of Edinburgh. The ANChor project (https://www.insitenorthsea.org/projects/anchor/), funded under the INSITE (INfluence of man-made Structures In The Ecosystem programme), established whether structures can connect species, populations and North Sea ecosystems. The findings showed that platform ecosystems have evolved to mimic those found in the wild and have the potential to contribute to natural ecosystems downstream (Henry, *et al*., 2017). Larval trajectories for the protected coral species *Lophelia pertusa* showed the capacity for ecosystems on man-made structures to benefit ecosystems downstream that have been degraded by human impacts and climate change. This capacity was robust across climate states proxied by the North Atlantic Oscillation (NAO), with the furthest most dense connections happening in a year when current strength would have been strongest. Even in low-flow conditions, trajectories carried larvae into areas with known naturally-occurring coral ecosystems. By 2012 under what was assumed to be the strongest current strength, larvae reached a range of coral ecosystems in the Norwegian Exclusive Economic Zone (EEZ) including those in the deep-sea, on the continental shelf and slope, and in coastal fjords. Most notable was the direct supply of larvae in just a single generation into a Norwegian coral marine protected area from the Murchison and Thistle A platforms. Corals on both platforms have been verified. The Aktivneset coral MPA was designated to protect coral ecosystems from further fisheries degradation, the wider region also being impacted by climate change. The partial removal of Murchison (as an OSPAR derogation case) is unlikely to have impacted this role, with corals located on the structure that remains, and that was still within the range of ANChor's experiments (Henry, *et al*., 2017).

European Protected Species (EPS) are a group of animals and plants protected by law throughout the EU by virtue of being listed in Annexes II and IV of the Habitats Directive 92/43/EEC. Cetaceans are the EPS most likely to be recorded in the region, even if only in low numbers. The European sturgeon (*Acipenser sturio*) and leatherback turtle (*Dermochelys coriacea*) are also classed as EPS and occur in UK waters, although the Project area is located at the furthest extent of their ranges and their occurrence in any numbers is unlikely.

The European Union meets its obligations for the conservation of bird species under the Bern Convention and the Bonn Convention, by means of the Directive 2009/147/EC (Birds Directive). It provides a framework for the conservation of wild birds in Europe, and includes provisions for the identification of SPAs for rare and vulnerable species listed in Annex I of the Directive, as well as for all regularly occurring migratory species, with particular attention to the protection of wetlands of international importance. Several species of seabird are known to use the Dunlin area, however, sensitivity is low to medium as discussed in Section 4.3.3.

Annex II species are protected under the EU Habitats Directive, which mandates that core areas of habitat these species rely upon must be protected under the Natura 2000 Network. The only species listed on Annex II of the EC Habitats Directive that is likely to occur in the vicinity of the Project area with any regularity is the harbour porpoise. The harbour porpoise is the most common cetacean in UK waters, being widely distributed and abundant throughout the majority of UK shelf seas, both inshore and offshore. Due to the species' wide geographical distribution and the lack of knowledge with regards to their feeding and breeding habitats, there has been difficulty in selecting sites essential for their life and reproduction, as required under the Habitats Directive. Although potential calving grounds have been identified in the German North Sea (Sonntag *et al*., 1999) no such areas are currently recognised in UK waters; a number of sites have been designated as candidate SACs for presence of harbour porpoise but none of these sites are located within the northern North Sea. Grey and harbour seals are also Annex II species but due to the distance from shore they are unlikely to be present in any significant numbers in the area.

Basking sharks, spurdog and blue shark (*Prionace glauca*) are listed on the IUCN red list and may be encountered in the Project area, but the area is not of specific importance for any of these species. The basking shark and spiny dogfish are classed as vulnerable under the IUCN red list. The blue shark is classed as near threatened. In addition, basking sharks are protected under the Wildlife and Countryside Act 1981 (as amended).

4.5. Socio-Economic Environment

4.5.1. Commercial Fisheries

4.5.1.1. Baseline Fishing Activity Analysis

Fairfield commissioned Xodus (2016) to complete a fishing risk assessment, which included an analysis of the potential impact of the subsea infrastructure decommissioning options on fisheries. As part of this, the baseline fishing activity in the vicinity of the Greater Dunlin Area was reviewed (Xodus, 2016). The study area considered to be relevant for the decommissioning activities is shown in relation to the International Council for the Exploration of the Sea (ICES) rectangles in Figure 4.13 (these rectangles are frequently used to understand how fishing effort varies in scale across the North Sea). The Dunlin Alpha installation is located at the junction of the three black lines shown in Figure 4.13.

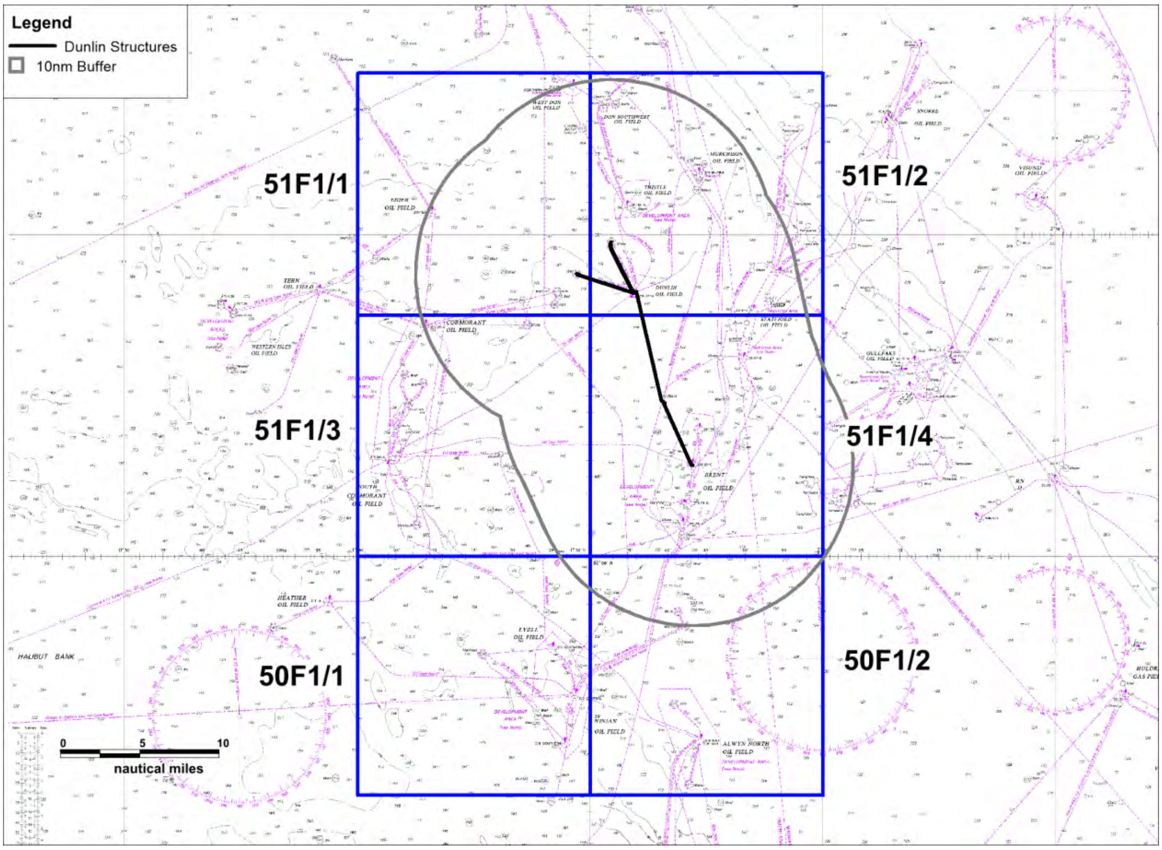


Figure 4.13 Baseline Fishing Activity Study Area: ICES Rectangles (Xodus, 2016)

To further inform this assessment, SFF Services were contracted to carry out a consultation with relevant members of the fishing industry. SFF Services collected primary data by interviewing fishermen who utilise the waters around the Dunlin Alpha installation. The vessel representatives interviewed provided output from their Global Positioning System plotters to highlight the fishing areas within the study area that they made use of.

4.5.1.2. Types of Fishery

Commercial fishing is excluded within 500 m of the Dunlin Alpha installation and the nearby Merlin and Osprey subsea drill centres as a result of safety zones having been implemented, but beyond this area within the surrounding ICES rectangle 51F1 there are two main types of fishery; demersal and pelagic.

Demersal fisheries target species which occur on or near the seabed whilst pelagic fisheries target species which occupy the water column. Within ICES rectangle 51F1 the demersal fishery is most productive in terms of landings value and tonnage. Some shellfish species are landed from ICES rectangle 51F1 but both value and tonnes landed are very low (Table 4.8). During the period 2012 – 2016, the live weight of demersal landings comprised between 300 and 1,000 tonnes for most years, except in 2013 for which live weight reached 1,084 tonnes. These demersal live weight values are considered moderate compared to other areas in the North Sea (NMPi, 2018).

Table 4.8 Annual Average Economic Value and Live Weight Tonnage from ICES Rectangle 51F1 from 2010 – 2014 (Scottish Government, 2017)

Species type	Live weight (tonnes)	Value (£)
Demersal	482	709,207
Pelagic	<1	12
Shellfish	<1	765
Total	**482**	**709,983**

4.5.1.3. Fishery Value

Kafas *et al*. (2012) report the Greater Dunlin Area as being at the northern extent of a large band of higher value demersal fishing effort, which stretches from the Outer Hebrides in the west, around Orkney and Shetland and down into the southern North Sea. Kafas *et al.* (2012) also report the Greater Dunlin Area being at the eastern-most extent of a large band of higher value pelagic fishing area that runs from the northern North Sea out to the west of the Outer Hebrides. ICES Workshop on North Sea Stocks (WKNSEA) report that the wider 'Viking' area, which covers the northeast North Sea of which Dunlin is a part of, as an area with the largest biomass of adult cod in the North Sea (ICES, 2015).

Saithe is the key commercial species landed from ICES rectangle 51F1 for both value (40%) and weight (52%), however, this is of relatively low value when compared to total landings into Scotland; landings of this species from ICES rectangle 51F1 comprise only 0.1% of the value (£) of 2016 landings into Scotland. Other species of commercial value in the same ICES rectangle include cod (13% of the total value for ICES rectangle 51F1), and ling (9.2%) (Scottish Government, 2017).

4.5.1.4. Gear and Fishing Effort

The only gear type used for fishing in ICES rectangle 51F1 by UK vessels is the trawl net, for which 62 days fishing effort were recorded in 2016 (Scottish Government, 2017). Trawls include demersal trawls (which typically contact the seabed) and midwater trawls which operate in the water column. Baseline fishing activity analysis suggests that single demersal trawlers are the most common trawl type (Xodus, 2016). Gear used by vessels of other nationalities includes long lines and seine nets (Xodus, 2016).

4.5.1.5. Seasonality

The average fishing effort in ICES rectangle 51F1 is 130 days per year (average over 2010 – 2014) (Scottish Government, 2017). Data on monthly fishing effort were obtained from the MMO for the time period 2010 – 2014 and analysed to establish seasonal trends. The Vessel Monitoring System (VMS) data show that most activity is concentrated in the spring and early summer months when five to twelve vessels are active in the area compared with fewer than four vessels per month at other times, as shown in Figure 4.14 (MMO, 2016). Review of Automatic Identification System (AIS) data, which represents an alternative method of tracking fishing activity, suggests that activity peaked earlier in the year in 2015 (Figure 4.15, Xodus, 2016). Seasonality must therefore be viewed as changeable over time, depending on market conditions, quota availability and weather.

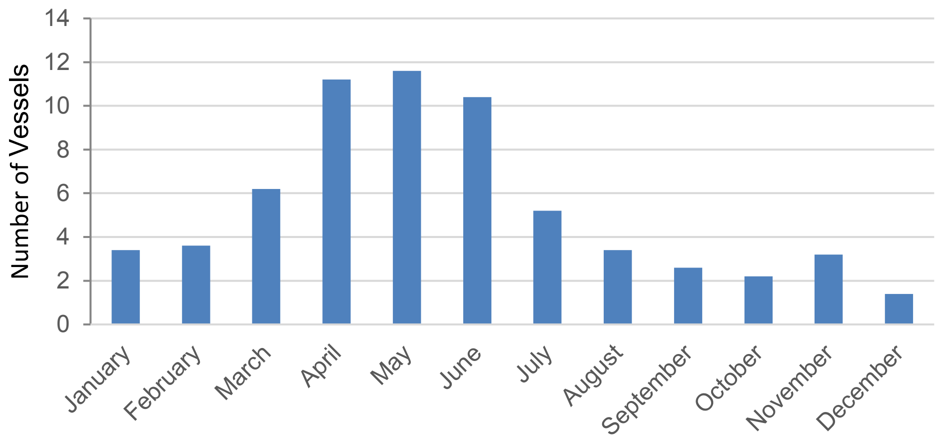


Figure 4.14 Seasonal Distribution of Vessel Presence in ICES Rectangle 51F1 Indicated by VMS Data (average 2010 – 2014) (MMO, 2016)

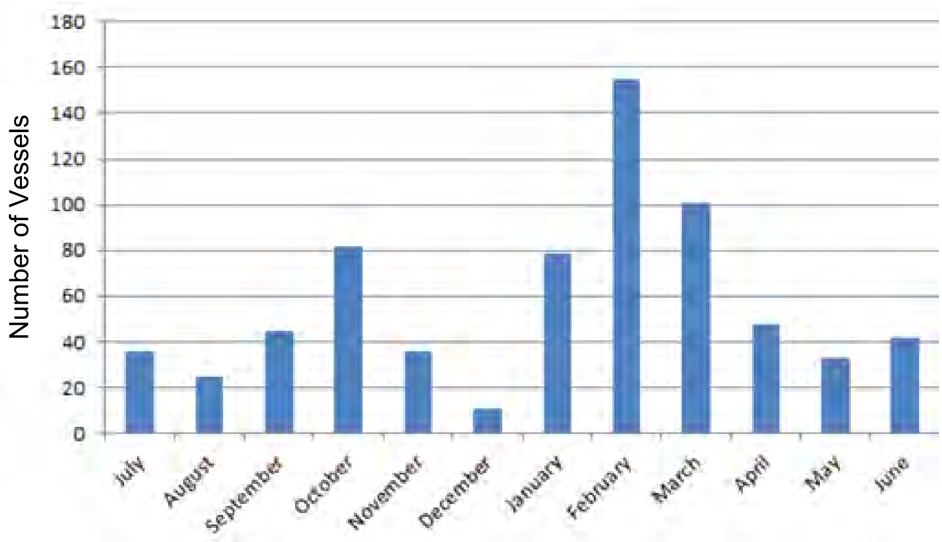


Figure 4.15 Seasonal Distribution of Vessel Presence in the 10 Nautical Miles (nm) Surrounding the Greater Dunlin Area, Based on AIS data for July 2015 – June 2016 (Xodus, 2016)

Fishing effort evidence from VMS data collected and analysed by the MMO, representing a five-year timescale from 2010 – 2014 has been mapped in Figure 4.16. This figure presents the average annual effort (time spent fishing in minutes) within ICES sub-rectangles ranked into four categories, from the lowest to the highest effort, giving an indication of the relative importance of the study area compared to the effort across the north east UKCS. For demersal fishing vessels, where there is the potential for interaction with subsea structures, Xodus (2016) estimate there to be one such vessel actively fishing in the study area every two days (Xodus, 2016).

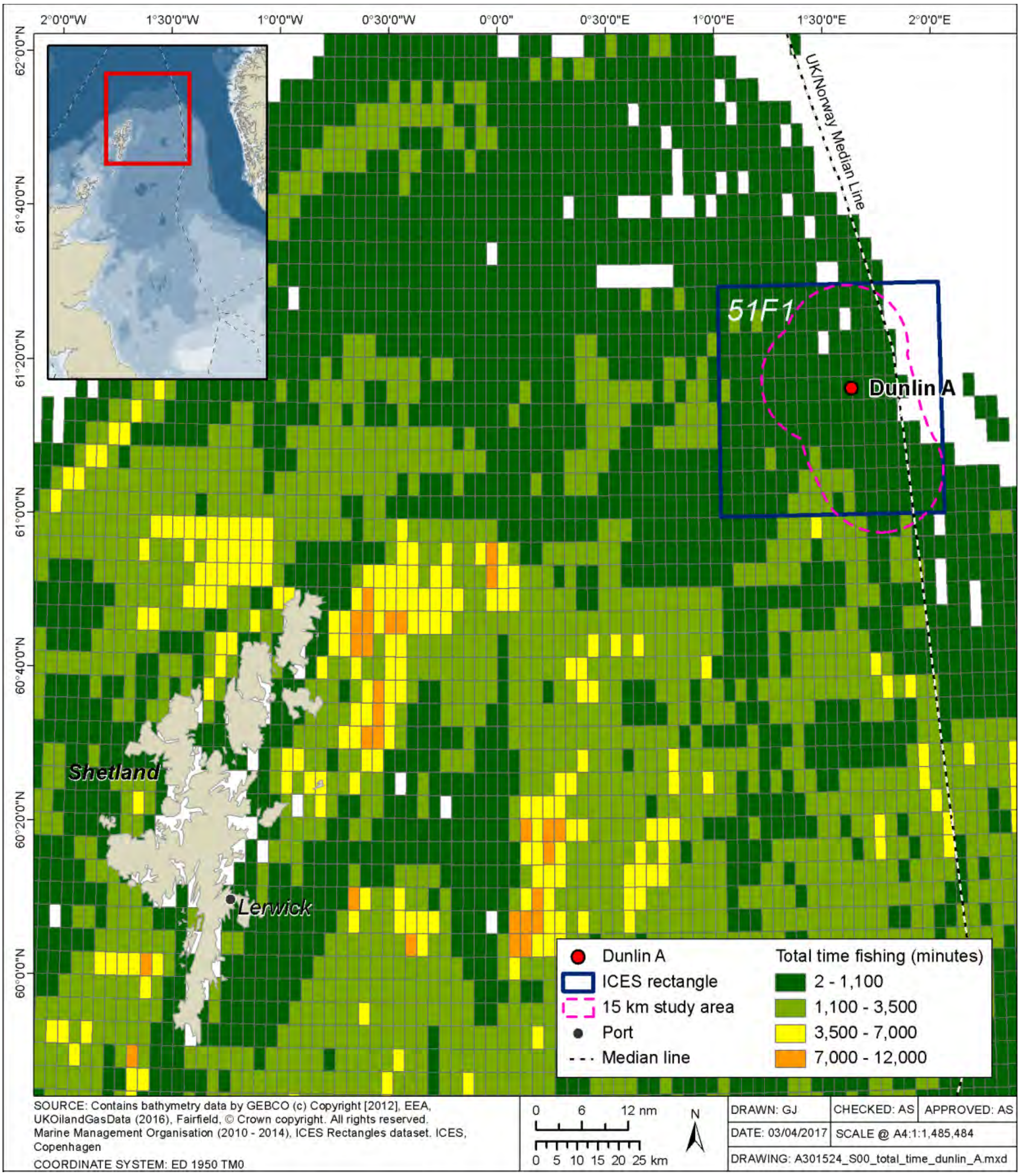


Figure 4.16 Relative Distribution of Fishing Effort (time in minutes) of Vessels Using Mobile Gear (average 2010 – 2014) (MMO, 2016)

In summary, although there is active fishing effort within the Greater Dunlin Area, it is much lower than elsewhere in the northern North Sea.

4.5.2. Oil and Gas Activities

The planned decommissioning activities are located in an area of extensive oil and gas development. There are a number of installations located within the vicinity of the Project area, as detailed in Figure 4.17.

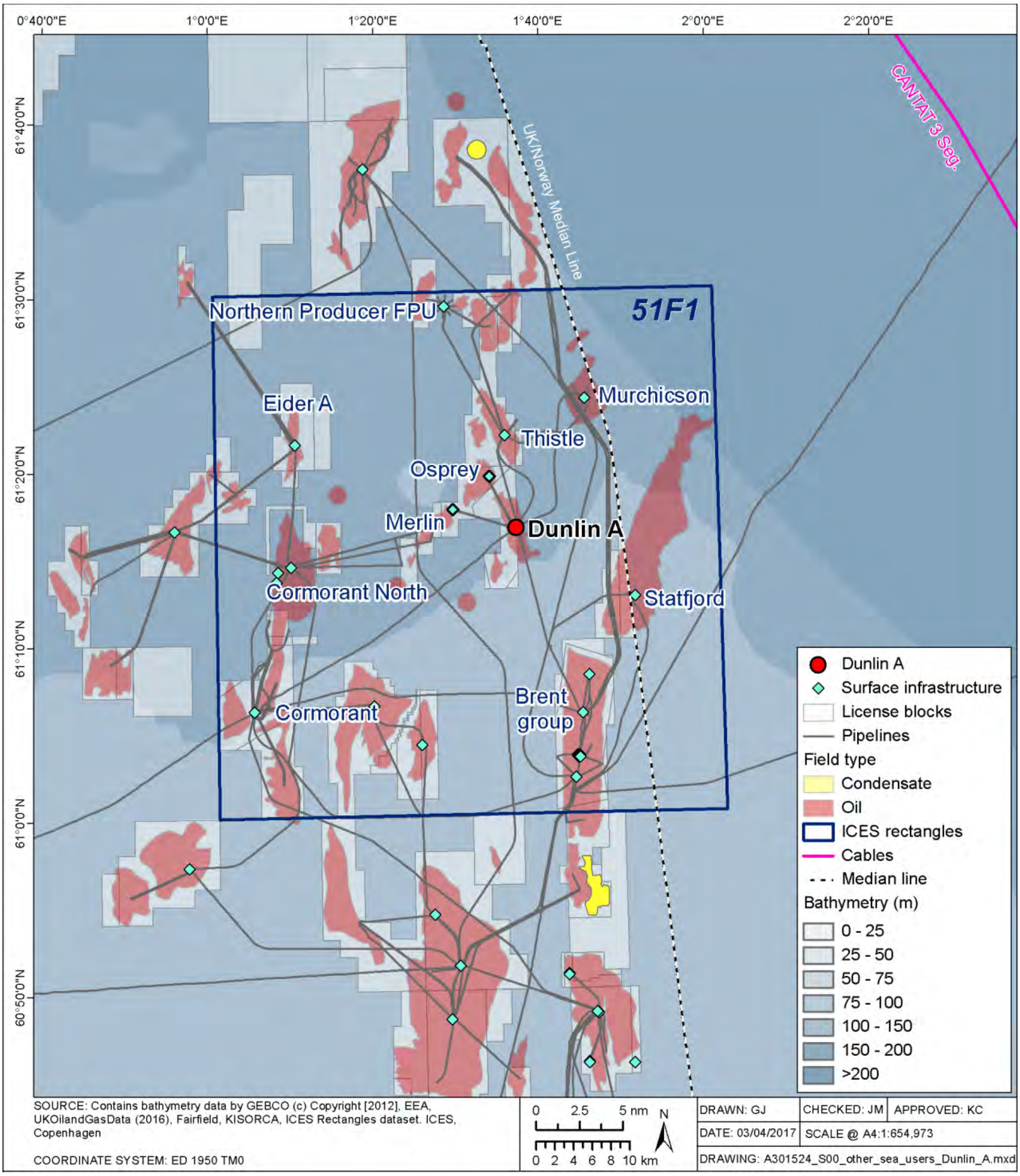


Figure 4.17 Other Sea Users in the Vicinity of the Dunlin Alpha Installation

4.5.3. Shipping Activity

The North Sea contains some of the world's busiest shipping routes, with significant traffic generated by vessels trading between ports at either side of the North Sea and the Baltic. North Sea oil and gas fields also generate moderate vessel traffic in the form of support vessels (DECC, 2016). Shipping activity is estimated to be low in Block 211/23 (DECC, 2016). An average of between 0.1 to 5 vessels per week pass the vicinity of the Project area with the majority of traffic consisting of small to medium sized cargo ships and tankers

(MMO, 2014). Other vessels that pass within the vicinity of the Project area include dredging or underwater operation vessels and fishing vessels.

4.5.4. Cables and Pipelines

There are no cables other than the Dunlin Power Import cable (running from the Dunlin Alpha installation to the Brent Charlie platform) in the vicinity of the Project area. There are several pipelines associated with the Greater Dunlin Area, including the Dunlin Fuel Gas Import Pipeline running from Thistle A to the Dunlin Alpha installation and pipelines connecting the Dunlin Alpha installation to the Merlin and Osprey tiebacks. In addition to these, other pipelines in the vicinity of the Project area include the Dunlin Alpha installation to Cormorant Alpha export pipeline (PL5), the Murchison oil export pipeline, Magnus to Brent A, Statfjord B spur, Penguins to Brent C, Brent C to Cormorant Alpha and Thistle to Murchison.

5. Impact Assessment

Fairfield is committed to ensuring that the CGBS storage cells are decommissioned in a manner that is safe for all users of the sea, and does not result in an unacceptable environmental impact. The information used to undertake the following assessments is based on evidence gathered from operational records, analysis of historical samples, analogous data and / or the application of proven scientific principles. Uncertainties associated with the base data have been assessed and where appropriate, conservative (worst-case) assessments have been applied to ensure environmental impact is not underestimated. Furthermore, the modelling undertaken to assess the potential for environmental impact has used conservative assumptions, as described in the following sections.

5.1. Cell Contents – Gradual Release Over Time

5.1.1. Overview

As discussed in Section 2.1.4, the residual contents of the cells have been extensively reviewed by Fairfield in order to characterise the materials in sufficient detail to allow potential environmental impacts to be appropriately assessed. Further details required to inform these assessments is provided in the following sections. There is the possibility that residual chemicals and hydrocarbons contained within the cells will gradually release to sea as the infrastructure degrades. Such a release could occur as the concrete walls degrade, with small holes forming in the walls and water exchange occurring with the outside marine environment. This could see buoyant, mobile oil in the cells released slowly over time. Additionally, as the concrete degrades and the concrete crumbles, the waxy residues (deposited from the produced fluids) that are bound to the cell wall will eventually be exposed to the marine environment. There is also sediment at the base of the cells, but it is highly immobile and unlikely to be distributed beyond the proximity of the cells as part of the gradual degradation of the structure.

5.1.2. Description and Quantification of Potential Impact

5.1.2.1. Mechanism for Gradual Release

The most credible scenario for release of cell contents over time is one occurring due to cracks in the concrete and communication paths opening up at existing pipework penetrations. Predicting the time to eventual failure of the structure is difficult given the lack of available cases for study, but Fairfield (2018c) estimate releases of this nature as likely to occur in the order of 20 to 1,000 years or more into the future; 20 years as result of pipework integrity resulting in a leak into the legs and 1,000 years as the result of concrete degradation resulting in a leak to sea. This prediction means the gradual release of cell contents to sea is likely to occur as a series of events that will occur hundreds of years into the future.

5.1.2.2. Gradual Release of Mobile Oil

The mobile oil within the cells is considered to be made up from the following:

- Residual oil left behind upon completion of the Attic Oil Recovery Project executed in 2007;
    - Residual oil could also contain:
        - Fluids from the topsides drain system such as solvents and effluents from cleaning, lubricating and hydraulic fluids, cooling fluids, etc.;

  - Trace quantities of chemicals such as demulsifiers injected into the topsides processing system; and
  - Heavy metals.
- Hydrocarbons which have diffused over time from the sediment layer on the floor or wall deposits.

The volume of mobile oil that is considered likely to be gradually released has been estimated based on there being 75 cells, each further sub compartmentalised within the cell roof space by the construction formwork into 36 smaller compartments. As the structure slowly degrades, it is reasonable to assume that a single sub-compartment could fail. As a result, it is expected that intermittent releases of up to 0.6 m^3 of mobile oil may occur over an extended period of time.

5.1.2.3. Gradual Release of Water

Loss of containment of a cell will also allow a slow interchange of the water phase with the seawater in the surrounding environment, which could result in release over a longer duration in the order of weeks to months following the loss of containment. The release of water will be at a low rate as there will be no significant pressure differential driving force between the internal and external of the cells; i.e. the cell contents are not sitting at a greater pressure than the outside seawater, and there will be no force to drive contents out in the event of a small breakthrough of the concrete structure. Hydrocarbons present within the water phase may be released from the cell through any new communication path created as the structure degrades and disperse into the water column. Such a release of water would have an associated release of aromatics and heavy metals within the water phase. However, Fairfield (2018c) describes the release of oil within the water phase as an order of magnitude smaller than the mobile oil release; THC of the water phase will be between 20 and 100 mg/l, with an average of approximately 40 mg/l. Additionally, there is the potential for chemicals to be released from the water phase. However, as discussed in section 2.1.4.4 the whole volume for the CGBS base caisson is expected to be approximately 214 kg of chemicals therefore due to the low concentrations of residual chemicals within the CGBS water, there is very limited potential for significant environmental.

5.1.2.4. Gradual Release of Sediment

The sediment at the bottom of the cells are not mobile. Upon exposure to the external marine environment, either through water passing in and out of the cells or from small concrete pieces breaking off and being exposed to the external environment, the hydrocarbons and heavy metals within the sediment may slowly diffuse into the water column.

5.1.2.5. Gradual Release of Waxy Residue

Waxy residues bound to the cell walls are not mobile, the wax is spread over the surface area of the cells within the CGBS. Upon exposure to the external marine environment, either through water passing in and out of the cells or from small concrete pieces breaking off and being exposed to the external environment, the hydrocarbons and heavy metals within the waxy residues may slowly diffuse into the water column.

5.1.2.6. Environmental Vulnerability to a Release

The receptors that could potentially interact with a gradual release of the cell contents are considered below.

Plankton

There may be impacts on plankton in the immediate area of the release until the release disperses, due to the dissolution of aromatic fractions into the water column (Brussaard *et al*., 2016). The impacts to plankton will be greater from an instantaneous release and is covered in Section 5.2.2.

Fish

Juveniles and eggs are the fish life-stages most vulnerable to chemical or hydrocarbon releases. The impacts to fish will be greater from an instantaneous release and is covered in Section 5.2.2.

Seabirds

In a nature conservation context, seabirds are the group at greatest risk of harm due to surface oil pollution in the offshore environment (JNCC, 2011). The most familiar effect of oil pollution on seabirds is the contamination of plumage, resulting in the inability to fly and loss of insulation and waterproofing, which alone may cause death. The impacts to seabirds will be greater from an instantaneous release and is covered in Section 5.2.2.

Cetaceans

Cetaceans are also present in the vicinity of the Dunlin Alpha installation (Section 4.3.4). The potential impact of a gradual release of cell contents will depend on the species and their feeding habits, the overall health of individuals before exposure, and the characteristics of the hydrocarbons. The impacts to cetaceans will be greater from an instantaneous release and is covered in Section 5.2.2.

Benthos

Benthic organisms could be exposed through deposition of solids that have settled out of the water column. Epifauna and infauna could be exposed through direct toxicity of components that are attached to deposited sediment particles. The uptake would be through direct ingestion of particles, or possibly through contact with tissues. Sessile organisms are most likely to be in prolonged contact with contaminated sediments (mobile species can take avoidance action to varying degrees). Additionally, an indirect disruption pathway of benthic function may be caused by oxygen depletion resulting from organic enrichment of sediments by hydrocarbons. The impacts to benthos will be greater from an instantaneous release and is covered in Section 5.2.2.

Bioaccumulation

When the cell structure eventually degrades, there is potential for the residual cell contents to come into contact with and be ingested by bottom-feeding biota and thereby enter the food chain. This could be both from direct feeding on the residues and feeding on seabed sediments contaminated by dispersed residues. However, given the probable lack of mobility of both the wax on the cell walls and the compacted sediment on the cell floors it is likely that the majority of the materials will remain in the vicinity of the site, even under a high energy failure scenario.

A screening assessment was carried out by METOC and reviewed as part of the CCTR study (Fairfield, 2018c) to investigate whether contamination from the residual cell contents at the site could contribute to a significant proportion of a limiting acceptable dose to a distant receptor, as a result of bioaccumulation. The assessment considered a range of substances of potential concern, including heavy metals and OSPAR priority substances, and was scenario based, with species in the food chain selected to be representative of viable pathways to deliver dose to the receptor.

Humans and marine mammals were considered as 'top-level' predators in the quantitative assessment, however 'lower' trophic levels (fish, crustacea, sediment re-workers and bacteria, moulds and fungi) were also considered qualitatively. Of the top-level mammals, the harbour porpoise is the least migratory (and therefore likely to be most affected). However, these have a relatively short lifetime (15 years) compared to humans, and also tend to spend their time close to shore, away from the site for most of the year. Humans were selected as the most vulnerable receptor, both on the basis of exposure as the 'top level predator' through potential consumption of food from the site, and because chemical specific dose limits are broadly available.

A potential pathway for environmental harm is through ingestion of the cell contents by biota and subsequent bio-accumulation through the food chain. This can take two forms: chronic impacts resulting from low dose levels over an extended period and acute impacts resulting from much higher doses over a short period.

From assessment of the potential chronic and acute impacts, the following conclusions were drawn:

- None of the components assessed could be delivered at sufficient rate, or for long enough duration, to lead to a significant (more than 1%) proportion of the chronic dose in humans.
- None of the components within the cells is capable of concentrating into the food chain in sufficient quantity to deliver an acute dose to humans.
- Only sessile, non-resistant species living on the outer boundary of the contaminated zone will be able to accumulate toxic levels of contaminants. These represent a very small portion of the regional population.

Species most likely to survive within any contaminated area are the lowest level forms which are generally least susceptible to contaminants and are able to take advantage of increased nutrients in the contaminated area. The ecosystem within the contaminated area will, therefore, be highly modified. However, these low trophic level species will tend not to pass contamination up the food chain in a bio-accumulative manner. Furthermore, for migratory species, the uptake of food from the vicinity of the CGBS will be a small proportion both on an individual and on a species basis. It was therefore concluded that environmental impacts to lower trophic levels will be confined to the site location and will be minor. Overall, it was concluded that the CGBS cell contents do not represent an unacceptable risk to humans through the uptake by the food chain of substances in the sediments.

5.1.3. Mitigation Measures

The Attic Oil Recovery Project, detailed in Section 2.1.4, removed the vast majority of the residual oil within the cells and there is now expected to be only a very thin evenly distributed layer of oil that now resides in the top attic space of every cell. The Attic Oil Recovery Project is the key mitigation measure that has been implemented in terms of reducing the potential for long-term impact from release of the cell contents.

In addition to this mitigation measure, there are inherent reasons why the potential impact is limited, such as the waxy residues being strongly bonded to the walls and cell contents being highly compartmentalised (as detailed in Figure 2.6). As such, Fairfield considers that implementation of further mitigation measures is not necessary.

5.1.3.1. Bioremediation

Bioremediation was initially considered as a management option to treat the CGBS cell contents *in situ*, in order to mitigate against potential future impacts. A wide range of organisms, particularly bacteria, algae and yeasts, are able to utilise crude oil components as a source of energy, with carbon dioxide being the end product. However, when assessing this option further, the following observations were made:

- The bioremediation process requires an oxidant, normally oxygen, and the Dunlin Alpha storage cells are an anoxic environment. Other electron receptors, such as sulphate or nitrate can be used, although such processes tend to be less efficient;
- If algae are an important component of the biodegrading process, light will also be required. As natural sunlight will not be available within the Dunlin Alpha storage cells, algae will not be a suitable material.
- Nutrients, particularly phosphate and nitrate, would need to be repeatedly supplied over time. This would require individual access to each cell and involve numerous interventions to check progress and replenish chemicals;
- The rate at which biodegradation takes place is temperature dependant, increasing rapidly between 5 and 30 C, although activity can occur within a temperature range from near 0 C to >40 C. The temperature within the Dunlin Alpha cell groups is approximately 5°C; and
- As well as temperature, another key factor in the effectiveness of the biological processes is the acidity or alkalinity of the environment, measured in potential Hydrogen (pH). The pH requirement will depend on the micro-organism selected. The existing environment within the CGBS cells is unknown but would likely require frequent adjustment through the addition of chemicals to ensure a suitable range.

Although the technology has been used in other situations, bioremediation of crude components in a closed environment, where light and oxygen is minimal and the ambient temperature is low, has not been tested. The effectiveness of the process is therefore unknown. Research into micro-organisms which can react in low temperature and low light environments (as in the Dunlin Alpha CGBS) is being carried out. However, the work is in its infancy and is some years (decades) away from achieving significant breakthroughs (if any). As a result, bioremediation as an active management option was not considered further.

It is noted that there undoubtedly will be ongoing biological processes within the storage cells, evidence of which has been seen during venting operations of gases from within the cells. This will result in a natural attenuation and degradation of the mobile oil. However, the rate at which this process occurs will be very slow and it is uncertain as to whether the processes can be sustained in the cell conditions, as discussed above when considering a more managed approach to bioremediation.

5.1.4. Cumulative Impact Assessment

It is possible that discharges from the cells could act cumulatively with releases from other assets in the area in the future to result in a negative impact to the surrounding environment. It is expected that up to a maximum of approximately 1,565 m^3 of mobile oil could be released from the cell contents over time. As a result of the water depth (151 m) and the release of such a volume occurring in small percentages over an extended duration (up to hundreds of years as the structures degrade), any discharge of mobile oil is expected to dissipate relatively rapidly and have no capacity to act cumulatively with discharges from other activities.

It is useful to note that other discharges to sea occurring as a result of activities in the Greater Dunlin Area associated with the Dunlin, Merlin and Osprey subsea infrastructure decommissioning will not occur within the same timescale as any gradual release of the cell contents.

5.1.5. Transboundary Impact Assessment

The gradual release of mobile oil and other contents of the cells will be over a prolonged period of time and will be of a relatively small volume at any one time. With the small volumes noted in Section 5.1.2, there is expected to be no transboundary impact.

5.1.6. Protected Sites and Species

Gradual release of cell contents during the degradation of the Dunlin Alpha installation will not occur within any SAC, SPA or NCMPA. Dispersal of any released contaminants will be such that there will unlikely be detectable interaction with any protected sites. As such, there is considered to be no Likely Significant Effect on SACs and SPAs and no impact on their conservation objectives or on site integrity through a release of contaminants from the cells. There will also be no interaction with any NCMPA, and no mechanism by which the sites could be compromised.

The video footage undertaken as part of the marine growth assessment (Xodus, 2017) showed that the only species of conservation significance identified as present is *L. pertusa*, the cold-water coral. This species is present on the deeper parts of all legs, below depths of approximately 48 m and on the CGBS (e.g. Fugro, 2017). *L. pertusa* is a reef-building cold water coral that provides habitats for other epifaunal and fish species and is a UK habitat of principle importance and a Scottish PMF; it is also highlighted in Annex I of the European Habitats Directive and is on the OSPAR List of Threatened and/or Declining Species and Habitats. This species is normally restricted to deep water in depth ranges of 200 – 2,000 m on the continental slope and the extent of *L. pertusa* reefs is undergoing an overall decline due to mechanical damage by demersal fishing gear in all OSPAR areas (OSPAR, 2009b). However, the species has also been recognised in the scientific literature as one which grows opportunistically on oil and gas subsea infrastructure (e.g. Gass and Roberts, 2006). The specimens of coral present on the structures are not likely to be affected by the slow and limited release of cell contents. Even if there was some detectable impact, however unlikely, the Dunlin Alpha installation is not located in an area of the North Sea where *L. pertusa* reefs are naturally established, with the presence of this species being solely a virtue of the presence of the introduced Dunlin Alpha installation. Therefore, any release of cell contents over time would not affect the natural extent and distribution of this species.

5.1.7. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Biological features	Low	Low	Low	Minor
Rationale				
The information in the Environment Description (Section 4) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. Biological features around the Dunlin Alpha installation will have some tolerance to accommodate the particular effects that could result from discharges (as a result of depth and refreshing of water column) and sensitivity is low. Additionally, there is potential for the residual cell contents to come into contact with and be ingested by bottom-feeding biota and thereby enter the food chain. However, as potential impacts are not likely to affect the long-term function of a system or a population, there will be no noticeable long-term effects above the level of natural variation experienced in the area and vulnerability is low. The fish populations in the Project area are characterised by species typical of the northern North Sea, with some spawning and nursery regions for commercially important fish and shellfish species occurring in the vicinity of the Project area. There appear to be low densities of cetaceans and seals within the Project area. There are no designated or proposed sites of conservation interest in the Project area. None of the survey work undertaken in the Project area has identified any benthic habitats or species that are of specific conservation significance (*L. pertusa* is not considered to be naturally present in the area). Value is therefore defined as low. The impact magnitude is Minor due to the anticipated release of a relatively small volume of residual chemicals and hydrocarbons over an extended period of time. There is expected to be limited potential for cumulative impacts from this anticipated release.				
Consequence		**Impact significance**		
Low		Not significant		

5.2. Cell Contents – Instantaneous Release

5.2.1. Overview

There is the possibility that residual chemicals and hydrocarbons contained within the cells will be released over a much shorter period of time than described in Section 5.1, in the event of a significant structural failure of the CGBS. This could see mobile oil, water, sediment and waxy residues distributed within the vicinity of the Dunlin Alpha installation in a relatively short timeframe.

5.2.2. Description and Quantification of Potential Impact

5.2.2.1. Mechanism for Instantaneous Release

Fairfield commissioned Atkins (2017b) to produce a technical review of the life expectancy of the concrete structure and how the structure might change over time.

The information from this study has been used to determine credible scenarios that could result in a future instantaneous release or exposure of the residual cell contents (Fairfield, 2018c). The worst-case scenario resulting in an instantaneous release involves an early failure of a transition falling from the top of a CGBS leg. Although highly unlikely, this could see a steel transition falling side-on through the water column onto the roof of CGBS base caisson. It is extremely unlikely that more than one steel transition would fall at the same time.

Considering the size of the steel transitions, it is possible that such an impact could result in the loss of containment from the storage cells. As detailed in Table 5.1, the volume of mobile oil that could be released is estimated to be 50 – 100 m^3.

It should be noted that should a steel transition fall onto the CGBS in the future, due to degradation of the structure, the mass of the steel will have significantly reduced (it could weigh only half of its original weight), and may not have sufficient mass and therefore impact energy to break through into the cells. Furthermore, the presence of the drill cuttings on the cell tops would provide an energy impact buffer for falling objects.

Table 5.1 Inventory Basis for the Instantaneous Loss of Containment of the Cells

Inventory	Volume (m^3)	Method of exposure to the marine environment
Mobile oil	50 – 100	Release into the water column
Water	13,000	Interchange with the water column
Sediment	190	Exposure, remaining within the concrete structure
Wall residue	40	Exposure, remaining adhered to the concrete structure

5.2.2.2. Modelling to Help Understand the Fate of a Release

The potential impact of any instantaneous release will be determined by the chemical characteristics of the release (including weathering potential), the circumstances and volume of the release, the environmental conditions at the time, the direction of travel of the release and the presence of environmental sensitivities in the path of the release. These environmental sensitivities will have spatial and temporal variations. Therefore, the likelihood of any release having a potential impact on the environment must take into account the likelihood of the release occurring against the probability of that hydrocarbon or chemical reaching a sensitive area and the environmental sensitivities present in that area at the time of hydrocarbon or chemical release.

Modelling for both a 50 m^3 and 100 m^3 oil release was undertaken to inform the Comparative Assessment process (described in Section 2.2.2). In addition, modelling of a 200 m^3 release has also been undertaken to allow for uncertainty in the release volume. Details of the modelling that was undertaken, including the software and input data, are provided in Appendix B.

Modelling output from the 100 m^3 release has been detailed in the text below and provided in Figure 5.1, and analysis for both a 100 m^3 and 200 m^3 release been provided in Table 5.2, Table 5.3 and Table 5.4 to ensure the assessment does not underestimate potential environmental impacts due to uncertainty in the volume of mobile oil released. The listed protected sites are summarised in the environmental baseline in Section 4.4.

From the release point for the 100 m^3 scenario, approximately 137 km north east of the nearest landfall point in the Shetland Islands, the metocean conditions (predominantly the wind) result in the surface oil moving south west (Day 3) towards the east coast of Shetland, away from the UK/Norway Median line. This results in the surface oil spreading parallel to the east coast of Shetland as the wind turns towards the west on day 6 resulting in beaching along most of the east coast of Shetland. While some of the remaining oil would be carried further south and east before dispersing (Day 30), most of the surface oil that did not beach would be carried west and north by Day 8 and would be naturally dispersed across a large sea area directly north of Shetland by Day 14. Beaching of oil is expected at four protected sites, whilst eight sites including SACs, SPAs and Marine Draft SPAs are predicted to receive some surface oil. The characteristics of the oil being Bonn Agreement Oil Appearance Code (BAOAC) 2 (0.3 – 5.0 μm) or below (i.e. sheen / rainbow appearance)[10].

It should be noted that this modelling is based on the worst case metocean conditions and is therefore considered to be worst-case. It is expected in reality that any release would disperse at sea.

[10] The characteristics of beaching for the 200 m^3 scenario is similar, with the exception that one site could see beaching of oil characteristic of BAOAC 3, described as ‘metallic’ in appearance.

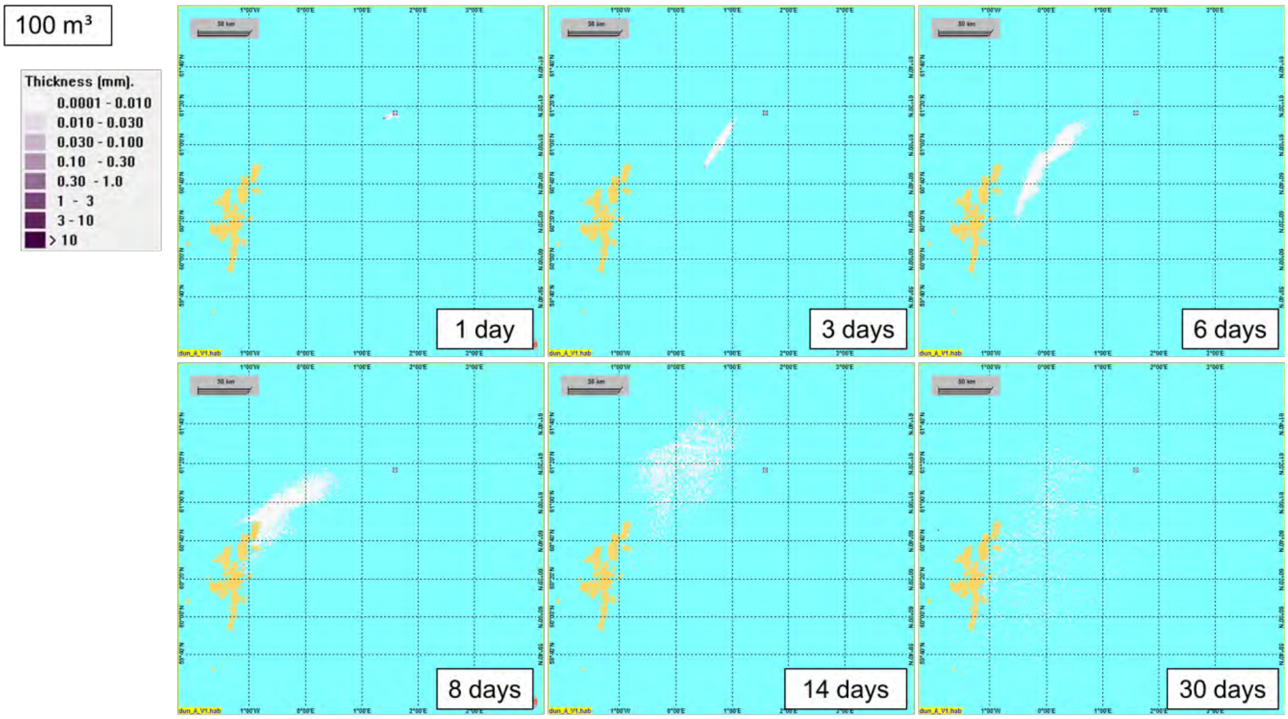


Figure 5.1 Surface Oiling for 100 m^3 Oil Release

The results of the two modelling scenarios covering are summarised in Table 5.2, Table 5.3 and Table 5.4. Protected sites are summarised in the environment baseline in Section 4.4.

Table 5.2 Surface Oil Thickness at Protected Sites

Protected site	Case 1 - 100 m^3		Case 2 - 200 m^3	
	Thickness (µm)		Thickness (µm)	
	Max.	Min.	Max.	Min.
Central Fladen NCMPA	2.82	0.31	0.98	0.64
Fair Isle SPA	-	-	1.83	0.91
Hermaness, Saxa Vord and Valla Field SPA	-	-	5.20	0.33
Fetlar to Haroldswick NCMPA	3.30	0.32	4.91	0.31
Pobie Bank Reef SCI	2.56	0.33	4.61	0.38
Yell Sound Coast SAC	1.15	0.34	2.33	0.37
Fetlar SPA	1.89	0.32	4.83	0.32
Mousa SAC	0.94	0.94	1.91	0.64

Protected site	Case 1 - 100 m^3		Case 2 - 200 m^3	
	Thickness (µm)		Thickness (µm)	
	Max.	Min.	Max.	Min.
Noss SPA	1.11	0.35	2.14	0.34
Mousa to Boddam NCMPA	1.04	0.33	-	-

Table 5.3 Shoreline Oiling

Shore line oiling	Case 1 - 100 m^3	Case 2 - 200 m^3
Occurrence of first oil to shore	6 days 18 hours	6 days 12 hours
First appearance of oiling above 0.1 l/m^2 (87 g/m^2)	Does not occur	8 days 3 hours
First appearance of oiling above 0.5 l/m^2 (430 g/m^2)	Does not occur	Does not occur
Maximum oiling (g/m^2)	51	150
Length of oiled shoreline (km)	268	318
Occurrence of max oiling	9 days 18 hours	11 days 6 hours
Maximum total stranded oil (te)	1.85	5.35
Occurrence of max total stranded oil	10 days 12 hours	11 days 0 hours

Table 5.4 Shoreline Oiling at Protected Sites

Protected site	Case 1 - 100 m^3		Case 2 - 200 m^3	
	Oil conc. (g/m^2)		Oil conc. (g/m^2)	
	Max.	Min.	Max.	Min.
Hermaness, Saxa Vord and Valla Field SPA	31.4	0.1	74.1	0.4
Fetlar to Haroldswick NCMPA	50.3	<0.1	142	<0.1
Yell Sound Coast SAC	2.6	<0.1	5.6	<0.1
Fetlar SPA	10.7	<0.1	39.9	0.1

Additionally, there is the potential for chemicals to be released from the water phase. However, as discussed in section 2.1.4.4 the whole volume for the CGBS base caisson is expected to be approximately 214 kg of chemicals therefore there is unlikely to be any significant effects.

5.2.2.3. Environmental Vulnerability to a Release

The receptors that could potentially interact with the release of the cell contents are considered below.

Plankton

There may be impacts on plankton in the immediate area of the release until the release disperses, due to the dissolution of aromatic fractions into the water column (Brussaard *et al*., 2016). Such effects will be greater during a period of plankton bloom and during fish spawning periods. Contamination of marine prey including plankton and small fish species may then lead to aromatic hydrocarbons accumulating in the food chain. These could have long-term chronic effects such as breeding failure in fish, bird and cetacean populations. This may also affect stocks of commercially fished species. However, the relatively small size of any release in comparison to the available habitat and the widespread populations of plankton and small fish is expected to limit the potential for these impacts to be realised.

Fish

Juveniles and eggs are the fish life-stages most vulnerable to chemical or hydrocarbon releases. As outlined in Section 4.3.2, a number of commercially important pelagic and demersal fish species are found in the vicinity of the Dunlin Alpha installation. Ten species are expected to use the Project area for spawning and/or nursery grounds at various times of the year. However, any release is not expected to affect fish spawning or recruitment success as the maximum release volume is relatively small, will be rapidly dispersed and the available spawning and nursery areas are very large.

Seabirds

In a nature conservation context, seabirds are the group at greatest risk of harm due to surface oil pollution in the offshore environment (JNCC, 2011). The most familiar effect of oil pollution on seabirds is the contamination of plumage, resulting in the inability to fly and loss of insulation and waterproofing, which alone may cause death. Individuals surviving these primary impacts are prone to ingest toxins whilst preening in attempts to remove contamination; this may result in secondary toxic effects. The seasonal vulnerability of seabirds to surface pollutants in the immediate vicinity of the Dunlin field, derived from JNCC block-specific data, suggest that seabirds in this area have a low vulnerability to surface pollution, although some of the blocks exhibit high vulnerability at certain times of the year (see Section 4.3.3). The magnitude of any impact will depend on the number of birds present, the percentage of the population present, their vulnerability to hydrocarbons and their recovery rates from oil pollution. Modelling suggests that the area of sea surface contaminated by hydrocarbons in the event of a spill will be very small, with a low probability of a surface sheen exceeding 0.3 μm thickness extending outside of the Project area (as shown in Figure 5.1). This means that even for the short periods of time when seabirds are present and spending time on the sea surface, there is little chance of interacting with surface oil.

Cetaceans

Cetaceans are also present in the vicinity of the Dunlin Alpha installation (Section 4.3.4). The potential impact of a release will depend on the species and their feeding habits, the overall health of individuals before exposure, and the characteristics of the hydrocarbons. Baleen whales are particularly vulnerable whilst feeding, as oil may adhere to the baleen if the whales feed near surface slicks (Gubbay and Earll, 2000). Cetaceans are pelagic (move freely in the oceans) and migrate. Their strong attraction to specific areas for breeding or feeding may override any tendency cetaceans have to avoid hydrocarbon contaminated areas (Gubbay and Earll, 2000). However, given the low density of cetaceans in the vicinity of the Dunlin Alpha installation and the rapid dispersal of an instantaneous release, there is not likely to be any impact on individuals or populations.

Benthos

With regard to the assessment of potential impacts from release or exposure of the solid material contents of the cells, the main parallels lie with cuttings piles contaminated with oil-based muds. Indeed, the most significant in-combination impact relates to the legacy of drill cuttings piles, specifically those that include oil-based mud residues from drilling operations. Surveys indicate that drill cuttings are present on the roof of the cells and extend down onto the seabed around the edges of the CGBS. Any disturbance to the roof of the CGBS cells including rupture exposing cell contents to the environment, would be accompanied by disturbance of cuttings pile material on the roof and, potentially, the combination of cuttings pile material with cell contents being released. The implications of this are as follows:

- A release of the solids content of the CGBS (e.g. from a high-energy failure scenario) through the side walls is likely to spill out over the footprint of the cuttings pile that has existed there since the mid-1970s. Thus, the immediate environmental impact of CGBS cell content release will occur within a benthic environment that has already been subjected to similar impacts for some considerable time;
- Plume development from a high-energy failure scenario could cause suspension of some of the cell sediment content, including waxy particles. The cell structure itself may have the effect of minimising the spread (i.e. any remaining walls would present a high barrier for the suspended particles to cross) but such disturbed material, if exiting the CGBS, would be more likely to settle within an existing zone of cuttings impact; and
- The cell contents have different contaminants and contamination levels to the degraded drill cuttings pile, therefore the effect of the pile will be to dilute levels of contamination from the residues, and potentially act as a barrier between the residual contents of the CGBS and the external environment.

A release of sediment from the base of the cells or of the wall residue bound to the concrete may lead to the smothering of benthic species and habitats due to sediment suspension and re-settlement. This may particularly affect the epifaunal species described in Section 4.3.1, with the degree of impact related to individuals' ability to clear particles from their feeding and respiratory surfaces (e.g. Rogers, 1990). There is no smothering sensitivity assessment available for the 'Circalittoral Mixed Sediment' biotope complex. Sensitivity of the two biotopes within the 'Circalittoral Muddy Sand' complex is low, with medium to high resistance and high recovery (Tillin and Budd, 2016, De-Bastos, 2016). Species characterising these biotopes are expected to be exposed to, and tolerant of, short term increases in turbidity following sediment mobilisation by storms and other events. There may be an energetic cost expended by individuals to either re-establish burrow openings, to self-clean feeding apparatus or to move up through the sediment, though this is not likely to be significant. Most animals will be able to re-burrow or move up through the sediment within hours or days.

With regard to the settlement of re-suspended sediments from the cells, the infaunal community is adapted to fluctuations in sedimentation levels and not likely to be particularly sensitive to temporary and localised increases. Tillin and Budd (2016) report on the abilities of buried fauna to burrow back to the surface. Results indicate bivalve molluscs are able to burrow between 20 – 50 cm depending on species and substrate; results for some species range from 60 cm in mud to 90 cm in sand. The abilities of the fauna to recover to the sediment surface will depend on the species and the burial depth, but as overtrawling is not expected to result in deep burial, success should generally be high.

Impacts upon benthic habitats and species from the above releases will be localised and are not expected to result in changes to the benthic community in the long-term.

Coastal Environment

The likelihood of a hydrocarbon release impacting the coastal environment is a function of the likelihood of such an event occurring and the probability of the hydrocarbon beaching. The level of impact is also directly related to the volume of the hydrocarbons released, the volume of hydrocarbon beaching, the composition of the beached hydrocarbons, and the type of beach and receptors present on the shore at the time of beaching. Based on the available modelling of the cell contents scenario being released at the Dunlin Alpha installation, it is considered a low probability that a release from the cell contents would reach a UK shoreline (Shetland). However, should some of the mobile oil reach the shore, the volumes would be very small and any such beaching oil would be rapidly dispersed in the rocky nearshore environment.

Bioaccumulation

Should a high energy impact breach the base caisson, there is the potential for the residual cell contents to come into contact with and be ingested by bottom-feeding biota and thereby enter the food chain. A detailed discussion on the potential for bioaccumulation is provided in Section 5.1.2.6.

A radiological impact assessment was also undertaken by an independent specialist to consider the potential impacts resulting from a release of NORM contaminated sediment from the CGBS. The assessment considered a worst case release scenario resulting in the greatest potential mass of NORM contaminated sediments being dispersed throughout an area capable of sustaining a small fishing vessel. The exposure of fishermen to the potential NORM release was considered to be acceptable, as it was concluded that no annual dose of any concern would arise as the result of even the worst case release scenario (ARPS, 2018).

5.2.3. Mitigation Measures

The main mitigation measure implemented in regards to a cell contents release is the Attic Oil Recovery Project, detailed in Section 2.1.4, that successfully removed the vast majority of the residual oil within the cells.

In addition to these mitigation measures, there are several reasons why the potential impact would be limited:

- Waxy residues are strongly bonded to the walls so will not be released instantaneously;
- Cell contents are compartmentalised (as detailed in Figure 2.6), limiting the circulation of hydrocarbons or sediments that could be released from any single ingress to the structure;
- The geometry of the cells makes it difficult for falling debris to physically pierce the cells; and
- Concrete legs are predicted to crumble rather than collapse.

Bioremediation was considered but as discussed in Section 5.1.3 will not be used as an active management option.

5.2.4. Cumulative Impact Assessment

It is important to consider the potential for impacts to arise from instantaneous release of the cell contents with similar in conjunction with similar releases from other installations in the wider area. In the North Sea, there are 12 CGBS facilities in the UK sector, 12 in the Norwegian sector, two in the Dutch sector and one in the Danish sector. Only one of these in present in the same sector as the Dunlin Alpha installation (Cormorant Alpha), and even then the facility is located in excess of 30 km away. Since any instantaneous hydrocarbon or chemical release from the cells at the Dunlin Alpha installation is expected to dissipate within days, it is considered very unlikely that additional similar nature releases from other CGBS facilities would occur in the same timeframe and thus act to produce a cumulative impact.

Decommissioning of the Dunlin Alpha installation may overlap temporally and geographically with the subsea decommissioning activities in the Dunlin, Merlin and Osprey area. The overlapping execution of these projects will result in higher than normal vessel densities in the area, increasing the risk of a dropped object hitting the cells. Mitigation measures, including identification and management of simultaneous operations (SIMOPS) and use of Automatic Identification System, are considered to reduce this additional risk to as low as reasonably practicable.

5.2.5. Transboundary Impact Assessment

There is the potential for released cell contents to cross into the Norwegian sector. However, the small volumes and the distance to the transboundary line (11 km) mean it is likely that the contents would be diluted substantially into the wider marine environment and thus not detectable at any specific point in Norwegian waters. As such, there will be no significant transboundary impacts associated with an instantaneous release from the cells.

5.2.6. Protected Sites and Species

5.2.6.1. Overview

Modelling of an instantaneous release of mobile oil from the cells has shown that it would be unlikely for this inventory to reach the shoreline; at worst, the very north-east coast of Shetland could receive a very small volume of oil depositing on the shoreline. Review of the quantities against the International Tanker Owners Pollution Federation scale for shoreline oiling shows that any beaching would be classed as “less than light” and may not even be detectable.

This section considers the potential for such a release from the cells to impact upon the conservation objectives (and ultimately site integrity) of important protected sites, specifically SPAs, SACs and NCMPAs. The output of the modelling described in Section 5.2.2 has been compared against the location of SPAs, SACs and NCMPAs to determine where there is considered to be the potential for interaction.

5.2.6.2. Direct Interaction with Coastal Sites

As outlined in Section 5.2.2, a worst-case release could result in a maximum of 5.35 tonnes of oil being dispersed over 318 km of shoreline, which is a very small proportion of that originally released.

Considering the low likelihood of released oil reaching shore, and the very low volumes involved, direct interaction with any coastal or onshore protected sites is not expected. However, should some of the mobile oil reach the shore, the volumes would very small and of a light rainbow / sheen character. Any such beaching would be rapidly dispersed in the rocky nearshore environment.

5.2.6.3. Direct Interaction with Receptors from Coastal Sites Found Offshore

In addition to direct interaction with a site (i.e. mobile oil from the cells crossing the boundary of a site), it is necessary to acknowledge that qualifying features of some sites are mobile (e.g. seabirds and marine mammals) and that some individuals may forage or move through the area within which a release has occurred. In terms of marine mammals for which sites are designated, as outlined in 4.4, the Southern North Sea candidate SAC, for which harbour porpoise is the proposed qualifying feature, is located 640 km south of the Dunlin Project area. Harbour porpoise are highly mobile, and records exist of individuals travelling over 1,000 km (JNCC, 2013b). It is not expected however that individuals associated with the Southern North Sea candidate SAC will occur in the Project area in sufficient numbers during any limited period over which a release would take to disperse to have a significant impact on the harbour porpoise population associated with the candidate SAC.

Sites designated for bottlenose dolphin, harbour seal and grey seal are present along the east coast of Scotland. However, the distance of the sites from the Dunlin Alpha installation and the range of the animals suggests no individuals from these sites will occur in the Project area and they are therefore excluded from further assessment.

It would be very difficult to assign seabirds identified within the vicinity of the Dunlin Alpha installation area to specific SPAs. For many species, once breeding is complete, individuals are no longer restricted to foraging within certain distances (i.e. foraging ranges) from their breeding colony as there is no longer any requirement to return to eggs or chicks. Furness (2015) defines biologically appropriate, species-specific, geographic non-breeding season population estimates for seabirds. For a number of key species there is strong evidence that once birds leave the breeding colony they become widely dispersed over large distances, often intermingling with birds from other breeding colonies (typically of the same species) and in some cases birds that have migrated from overseas breeding colonies (Furness, 2015). Consequently, the potential for a cell contents release to have population level impacts on birds from any single SPA is much reduced. Potential impacts on birds from protected sites during the non-breeding season (i.e. when they are offshore) are therefore expected to be negligible.

5.2.6.4. Direct Interaction with Offshore Sites

For direct interaction with offshore sites without a land component, surface occurrence of released hydrocarbon within the site is taken as an indication that the site has the potential to be impacted. The closest protected site to the Project area is the Pobie Bank SCI, which is 98 km away at the closest approach. This site is designated for seabed features that would not be affected by a limited volume of oil being present on the surface. There will therefore be no significant impact on any offshore protected sites.

5.2.6.5. Protected Species

In addition to protected species that are associated with protected sites and which are discussed above (e.g. seabirds, cetaceans), there are several species that are expected to occur in the area that are protected but not associated with a site designation. For example, basking sharks, spurdog and blue shark are all on the

IUCN red list; basking sharks are also protected under the Wildlife and Countryside Act 1981 (as amended). All three species are expected to occur in the area, although not in numbers that are important in a population context, especially for the limited period over which a release would take to disperse. It is not expected that a release from the cells would have a significant impact on any of these three species.

Some benthic species, such as the ocean quahog, are protected. However, as discussed above, instantaneous release of the cell contents is not expected to result in substantial interaction with the seabed and there will therefore be no significant impact on protected benthic species. This also applies to *L. pertusa*, with further discussion on that species provided within the gradual release assessment in Section 5.1.6.

5.2.7. Residual Impact

<table>
<tr><th>Receptor</th><th>Sensitivity</th><th>Vulnerability</th><th>Value</th><th>Magnitude</th></tr>
<tr><td>Biological features</td><td>Low</td><td>Low</td><td>Low</td><td>Minor</td></tr>
<tr><th colspan="5">Rationale</th></tr>
<tr><td colspan="5">The information in the Environment Description (Section 4) has been used to assign the sensitivity, vulnerability and value of the receptor as follows.
Biological features around the Dunlin Alpha installation and along the potential route of mobile oil to shore will have some tolerance to accommodate the particular effects that could result from discharges (as a result of depth in the offshore area and of refreshing of water column along the route) and sensitivity is low. As potential impacts are not likely to affect the long-term function of a system or a population, there will be no noticeable long-term effects above the level of natural variation experienced in the area and vulnerability is low.
The fish populations in the Project area are characterised by species typical of the northern North Sea, with some spawning and nursery regions for commercially important fish and shellfish species occurring in the vicinity of the Project area. There appear to be low densities of cetaceans and seals within the Project area. There are no designated or proposed sites of conservation interest in the Project area. None of the survey work undertaken in the Project area has identified any benthic habitats or species that are of specific conservation significance (L. pertusa is not considered to be naturally present in the area). Value is therefore defined as low.
The impact magnitude is Minor due to the anticipated release of a relatively small volume of residual chemicals, hydrocarbons and sediments. There is expected to be limited potential for cumulative impacts from this anticipated release.</td></tr>
<tr><th colspan="2">Consequence</th><th colspan="3">Impact significance</th></tr>
<tr><td colspan="2">Low</td><td colspan="3">Not significant</td></tr>
</table>

5.3. Drill Cuttings Disturbance

5.3.1. Overview

As the CGBS begins to degrade over time, there is the possibility that the drill cuttings on the roof of the cells and around the base of the CGBS could be disturbed by falling objects. The subsequent possible re-distribution and re-settling of the cuttings has the potential to impact upon the benthos in the vicinity of the Dunlin Alpha installation.

5.3.2. Description and Quantification of Potential Impact

5.3.2.1. Understanding the Fate of a Release

Drill cuttings that are left *in situ* are expected to remain relatively undisturbed by seabed currents, and the proposed maintenance of the 500 m safety zone around the Dunlin Alpha installation will negate disturbance by commercial trawling (Section 5.3.1 covers the potential impact on commercial fisheries of exclusion from the area). Any debris clearance that takes place will not disturb the cuttings piles i.e. through overtrawling.

To assist in estimating environmental impacts, OSPAR has defined an 'ecological effect' threshold for cuttings piles of 50 ppm (50 µg of hydrocarbons per gram of sediment by dry weight) (OSPAR, 2006). This means that using sufficiently robust survey data, it is possible to estimate the area of a given cuttings pile which may be considered as having an environmental impact (the areas where hydrocarbon content exceeds 50 ppm), and locate the boundary outside of which the environmental impact can be considered negligible. The Dunlin Alpha cuttings pile threshold was calculated using evidence attained from MBES and chemical survey results, which was assessed using an Eiva NaviModel and a gridding method (Fugro, 2018). The spatial extent of the cuttings pile above the ecological effects threshold was calculated to be 0.671 km^2 and is shown spatially in Figure 5.2.

The undisturbed cuttings pile will continue to have an impact on the benthic community living in the sediments that make up the pile, as indicated by the reduced number of taxa described in the cuttings pile survey (Fugro, 2018). The hydrocarbon content of the pile will also have a small impact on the area immediately surrounding the 'ecological effect' boundary, as hydrocarbons gradually leach out of the cuttings and into the water column, and contaminated sediments from the cuttings pile are redistributed to the surrounding seabed by natural processes. This impact is expected to be small as evidenced by the current presence of a benthic community close to the cuttings pile that is generally species rich, diverse, homogenous and representative of the wider region as discussed in Section 4.3.1. The worst-case hydrocarbon leaching rate has been calculated at 1.75 te/yr (Fugro, 2018). This is well below the OSPAR limit of environmental significance of 10 te/yr (UKOOA, 2005).

It is possible to estimate the persistence of a cuttings pile using the area of the pile that is above the ecological effect threshold and a conversion factor presented in UKOOA (2005). This gives a persistence value in "km^2 years". A persistence of 1 km^2 year would indicate a pile of 1 km^2 persisting for 1 year and equally a pile of 0.1 km^2 persisting for 10 years. The Dunlin Alpha installation cuttings pile is expected to have a persistence of 47.4 km^2 years. The area of the cuttings pile that is above the ecological effect threshold is currently 0.671 km^2, which at a constant rate of size reduction would suggest a persistence of 70.6 years. However, the initial rate of leaching will reduce over time in line with the gradual reduction in hydrocarbon content in the pile. The majority of the hydrocarbons would therefore leach out during the first part of the degradation period, which would tail off with a small remnant cuttings pile remaining in place for much longer than 70.6 years, but releasing smaller and smaller amounts of hydrocarbon.

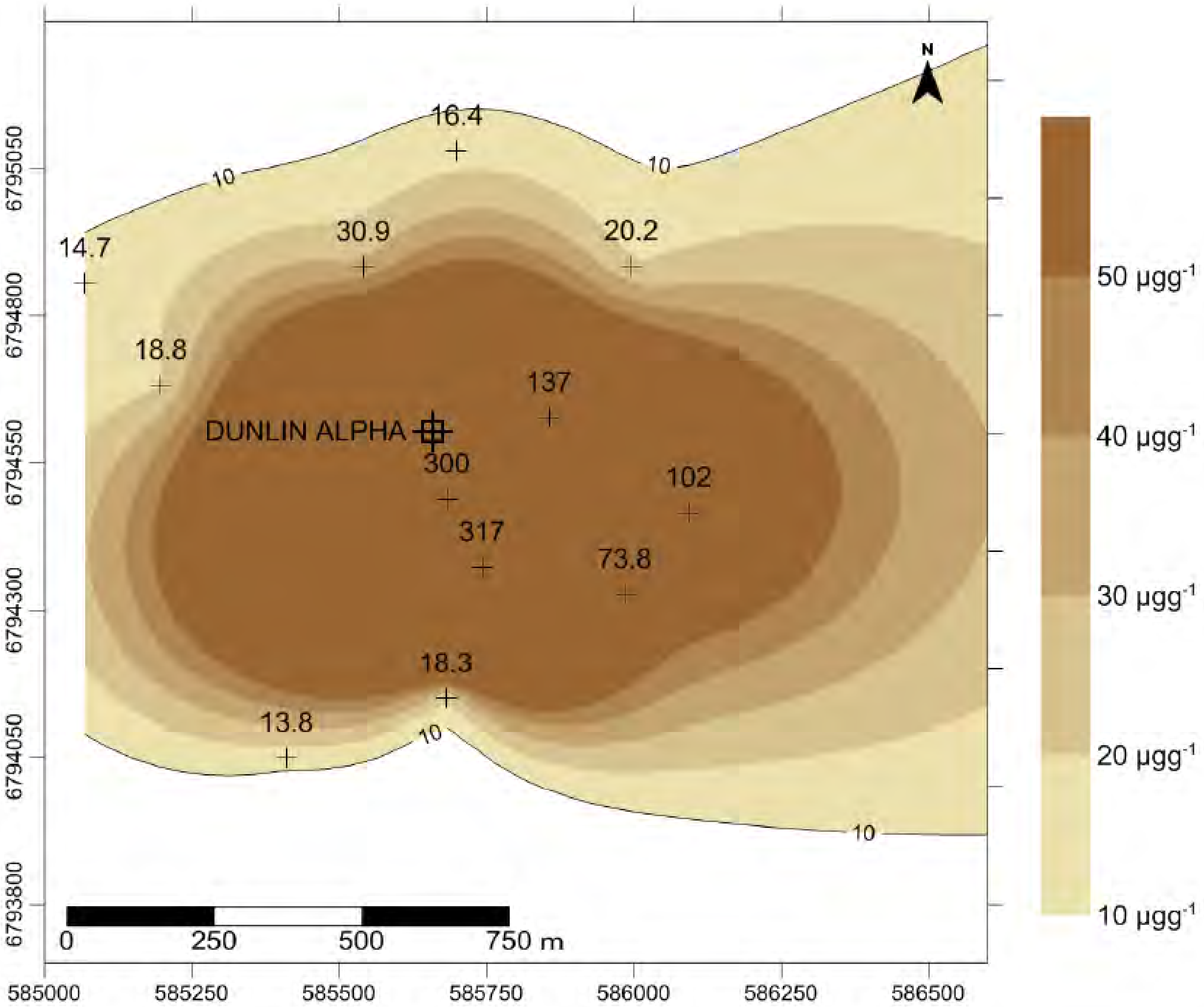


Figure 5.2 Spatial Distribution of Surface Sediment Total Hydrocarbon Concentrations Showing 50 ppm Hydrocarbon Content Boundary

Whilst the cuttings pile on the seabed and cell tops is not expected to exert a significant negative environmental impact when left *in situ*, it is possible that future disturbance of the cuttings pile on the cell tops could be caused as the CGBS begins to deteriorate and pieces fall onto the cuttings pile that remains on the top of the cells. As described in Section 5.2.2.1, the failure of a transition is considered to be worst-case in regard to a dropped object with an estimated impact energy of 10 – 15MJ (Atkins, 2017b), although it is likely that numerous smaller impacts will also disturb the drill cuttings pile over time. Ultimately the roof of the CGBS base caisson is expected to collapse in approximately 1,000 years' time, resulting in the disturbance of any drill cuttings that remain at that time (expected to be extremely limited, given the calculated persistence of 70.6 years).

5.3.2.2. Dropped Object Modelling

Each time a piece of infrastructure falls into the cuttings pile on top of the roof of the cells, cuttings material is likely to be re-suspended into the water column. The specific degree of re-suspension is not quantifiable without detailed analysis due to the large number of variables at play including shape and orientation of falling objects, the energy that might be absorbed by deformation of the falling object on impact, the degree of cementation of the cuttings pile and its consequent structural strength and the potential for the base cells to deform and absorb some of the energy. Further, the timing of material falling onto the cuttings pile will determine the potential for impact from any redistribution, since the cuttings pile will degrade over time – the later that a dropped object lands on the cuttings pile, the further degraded will be the constituents of the cuttings pile.

Despite the uncertainties regarding the exact method and timing of interaction between a falling object and the cuttings pile, modelling has been undertaken to quantify the potential impact of a dropped object. Details of the modelling that was undertaken, including the software and input data, are provided in Appendix B. Whilst the results of modelling cannot be directly substituted for observed impacts occurring during an actual dropped object event, it is a useful tool to help assess the magnitude of risk that is posed. To account for the uncertainties, modelling was conducted under three scenarios, considering disturbance of 1%, 5% and 10% of the cell top cuttings pile respectively, as described in Appendix B. The modelled thickness of the deposited drilling mud disturbed during the 10% cell top cuttings pile dropped objects scenario is presented in Figure 5.3. These figures show that the predicted drill cuttings distribution immediately around the CGBS will be a maximum of approximately 100 - 300 mm in thickness. The cuttings pile thickness is predicted to rapidly decreases as the distance from the CGBS increases, such that around approximately 1 km from the CGBS the cuttings thickness has decreased to a maximum of approximately 1 mm thick. Wider scale deposition of small amounts of finer material are predicted by the modelling, but the amount of material deposited is likely to be very small (less than 0.1 mm thick) and distributed over a large area (several kilometres) such that it would not be readily detectable.

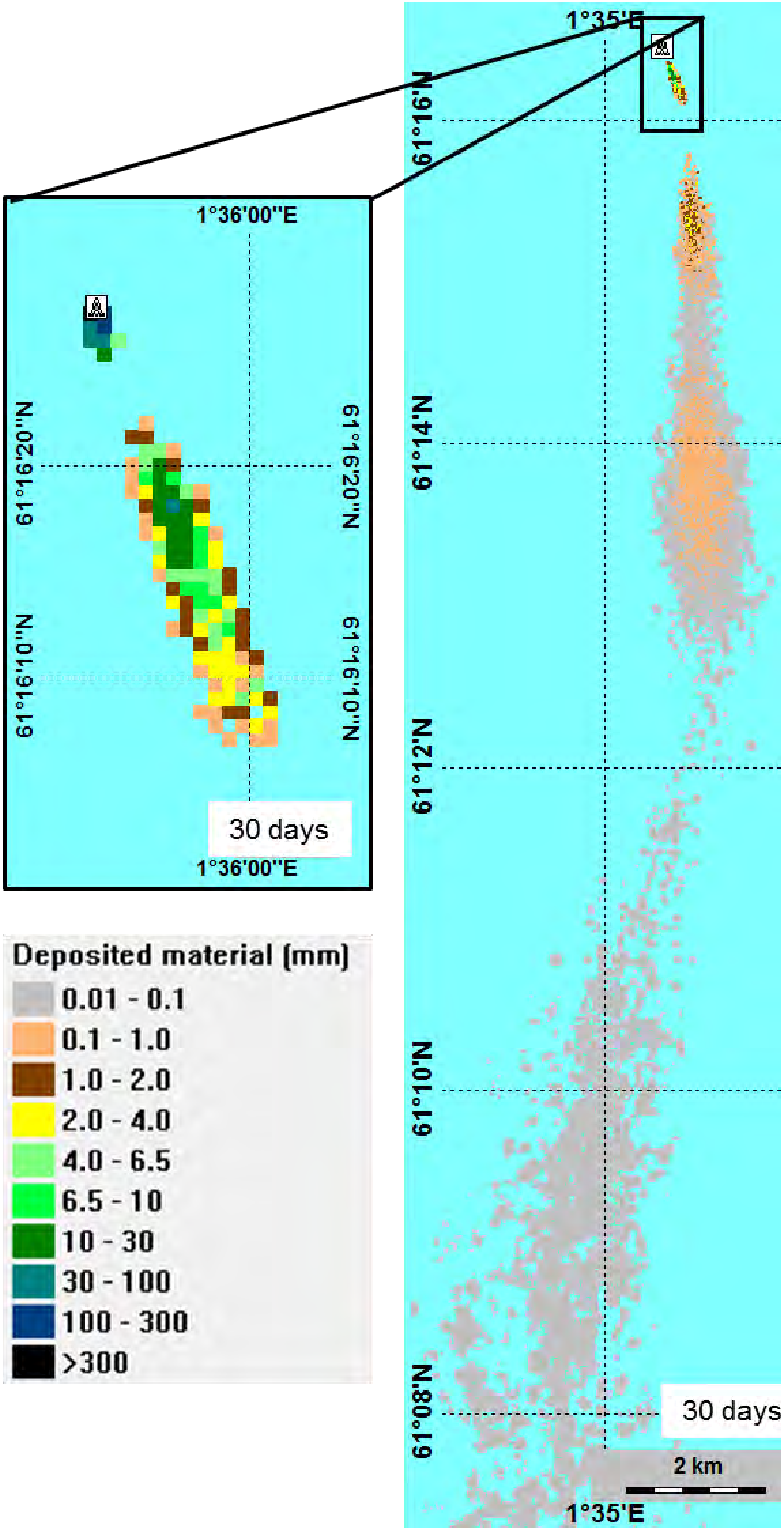


Figure 5.3 Accumulation on the Seabed of Redistributed Cuttings

Further to the spatial extent of cuttings redistribution, the modelling also calculates an Environmental Impact Factor (EIF), a common approach in environmental modelling. EIFs are a relative measure of risk to the biota in the marine environment. They are calculated using the 'PEC/PNEC approach', in which the predicted environmental concentration (PEC) of a contaminant is divided by the predicted no effect concentration (PNEC; the highest concentration at which no environmental effect is predicted):

- The PEC for each contaminant is determined within the model using a number of calculations to simulate the behaviour of contaminants in the water column. Processes including dilution, partitioning, degradation and deposition into the sediment are simulated in order to generate a PEC for each contaminant over time. EIFs for the sediment compartment are more complex, incorporating toxicity of contaminants, but also processes such as oxygen depletion, change in median grain size and burial effects; and
- The PNEC values within the model are estimated highest concentrations at which toxic effects are not expected. The PNEC values for each substance is defined by laboratory tests divided by an assessment factor to produce a value that is considered to be protective of all but the most sensitive 5% of species. This approach is internationally accepted in the regulatory assessment of chemicals. SINTEF have adapted this methodology by using experimental data to calculate pseudo-PNECs for non-toxic stressors such as burial, sediment grain size change and oxygen depletion.

A PEC/PNEC ratio of >1 indicates there is likely to be an environmental effect.

As indicated by the sediment EIF plot in Figure 5.4, the value of >1 is exceeded for the duration of the simulation, and some degree of environmental impact to biota within the sediment is therefore to be expected.

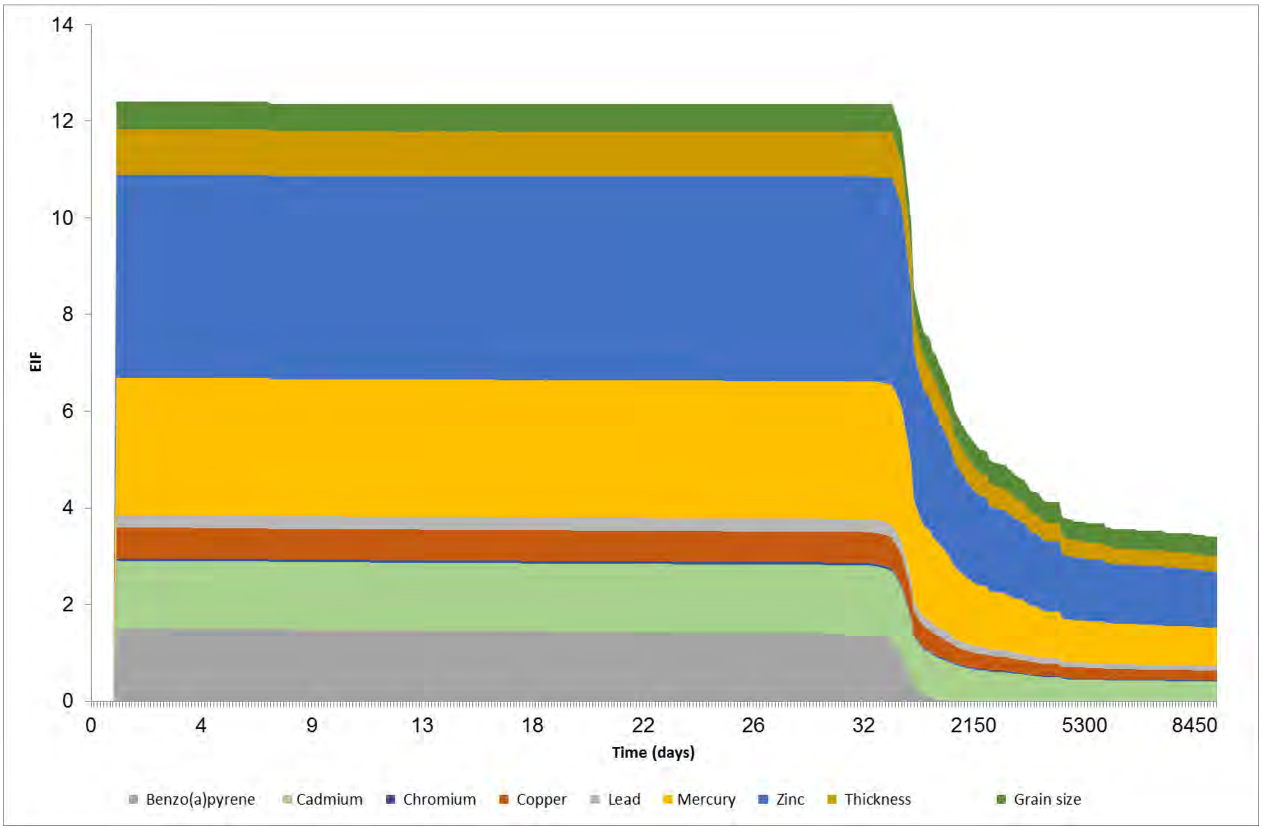


Figure 5.4 Sediment Impact and Recovery

It should be noted that SINTEF, the developers of the DREAM (ParTrack) model clearly state that the EIF is not a measure of absolute impact, but rather a comparative tool to support environmental management decision making. As such, the absolute value of the EIF is not meaningful alone; however, comparison of EIF values for different discharge scenarios based on equivalent assumptions provides a powerful tool for understanding and comparing potential impacts of these scenarios. A sediment EIF value is considered relatively small for drilling discharges, equating to impact on an area of 0.12 km^2 at the time of discharge. As shown in Figure 5.4, the area of impact has declined to around 0.08 km^2 after one year (i.e. an EIF of 8) and further to 0.04 km^2 after around 10 years. The area impacted will continue to decline as time continues.

Given that the extent of the seabed and cell tops cuttings pile in its current condition which exceeds the ecological effect threshold is 0.671 km^2, temporally limited impact on a further maximum area of 0.12 km^2 does not represent a substantial additional spatial area of impact. It should also be noted that some of the 0.12 km^2 that is predicted to be impacted may already be occupied by the existing pile and therefore already subject to some impact (i.e. additional cuttings deposition will impact this seabed to a lesser degree than seabed that is not already occupied by cuttings).

In addition to the potential impact on the seabed, the model also provides estimates of interaction with the water column. As with sediment EIF, a water column EIF of >1 can be considered the threshold at which impact may begin to occur; this is represented by the area shown as exceeding 5% risk in Figure 5.5 and Figure 5.6. As can be seen, an EIF >1 is predicted to develop over an area that extends, at its peak, approximately 40 km from the Dunlin Alpha installation, but which is limited to depths of in excess of 100 m.

Although the spatial extent of the water column impact appears greater than that for sediment, water column impact typically persists for a lesser period, and it is important therefore to view the above distribution in the context of the EIF time plot, shown in Figure 5.7. This plot shows an EIF peaking at around 20,000, which would equate to approximately 2 km^3 of the water column experiencing an impact at a maximum. However, the EIF falls to zero within approximately 14 days of the cuttings redistribution, a time beyond which no further impact would be exerted.

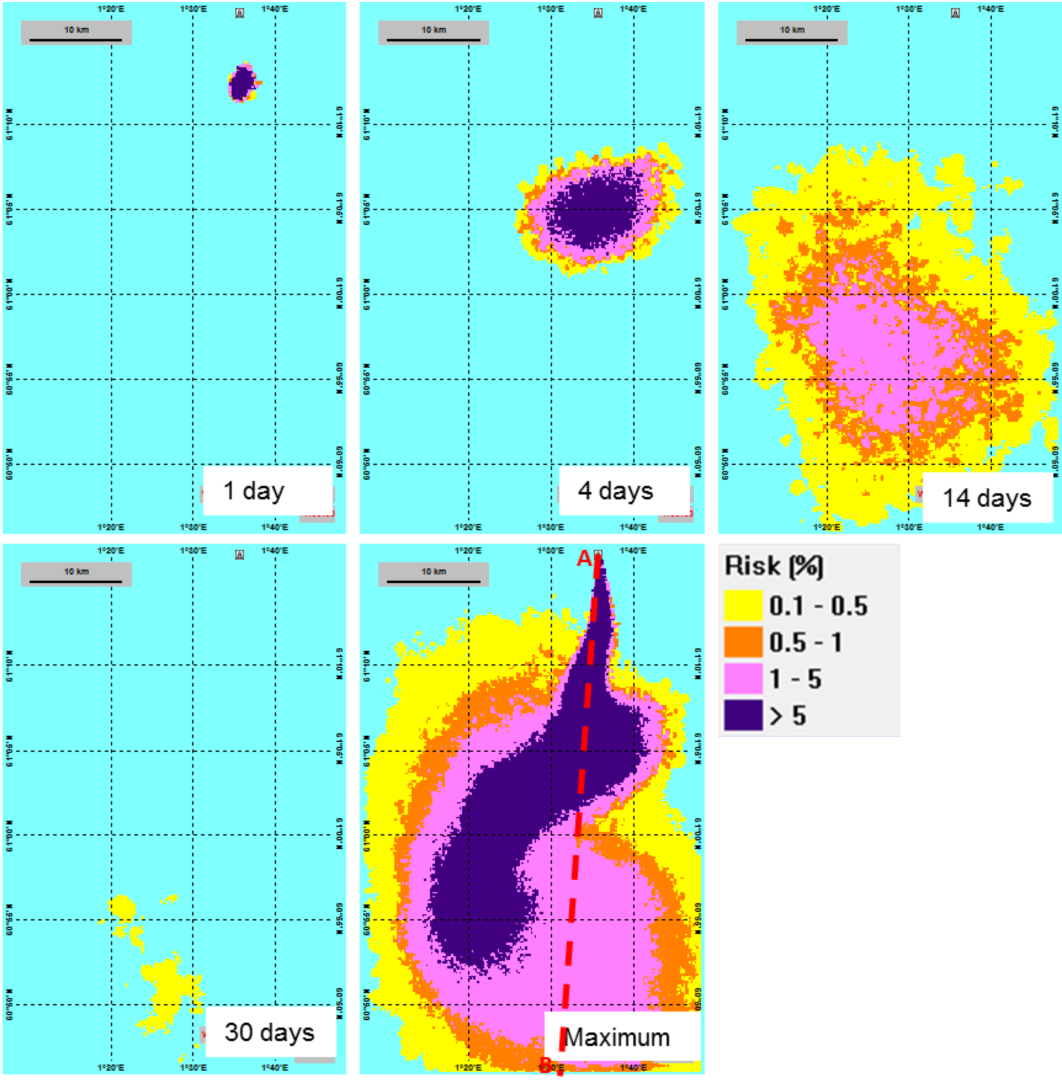


Figure 5.5 Water Column Risk – Plan View

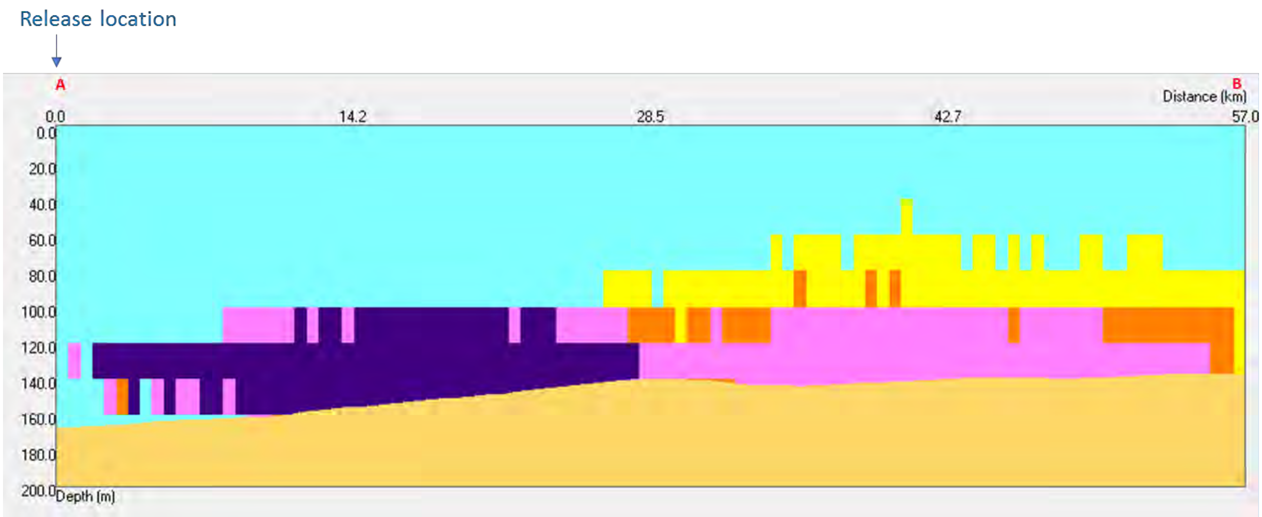


Figure 5.6 Water Column Risk – Section View of Maximum Extent

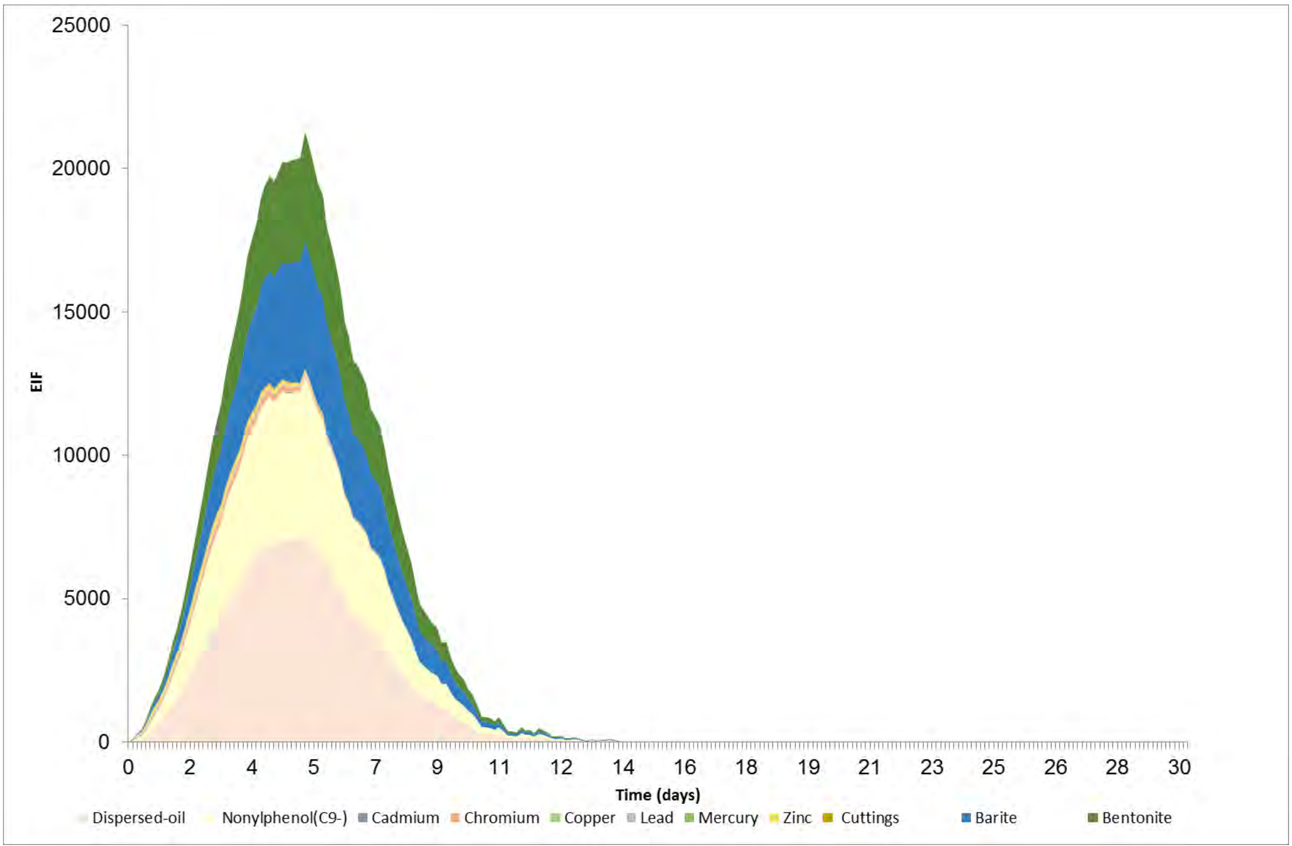


Figure 5.7 Water Column Impact and Recovery

5.3.2.3. Evidence from other cuttings pile studies

Modelling conducted by DNV (reported in OSPAR, 2009a) undertaken as part of wider research on the potential impact of drill cuttings being left *in situ*, estimated that of drill cuttings material disturbed by trawling events (an analogous impact mechanism to objects being dropped on the cuttings pile), 96.7% would immediately re-settle without becoming suspended in the water column. 3.3% of the disturbed drill cuttings would become suspended, with 2.47% re-settling within the existing accumulation area and only 0.83% re-settling outside of the existing accumulation area. Assuming as a worst case that the entire volume of the cuttings pile was disturbed in a single event (and not taking into account any degradation of the cuttings pile between now and the disturbance event) this would represent a disturbance of 10,200 m^3 of cuttings. If the modelling assumptions for the DNV modelling are also representative of this scenario, approximately 9,863.4 m^3 of cuttings would re-settle immediately and 336.6 m^3 would become suspended, of which 251.94 m^3 would re-settle within the original accumulation area and 84.66 m^3 would re-settle outside the existing accumulation area. Such limited redistribution is also apparent in the modelling results presented above.

The limited extent of redistribution and impact predicted by the modelling is further corroborated by the observations of several instances of actual cuttings pile disturbance reported in OSPAR (2009a), which were as follows:

- High intensity overtrawling of a cuttings accumulation in 70 m water depth resulted in spread of contamination, but not at a rate likely to pose wider contamination or toxicological threats to the marine environment;

- Dredging of the North West Hutton platform cuttings pile (including repeated dredge backflushes resulting in significant re-suspension of cuttings material) showed:
    - Drifting of re-suspended material was low during operations;
    - Hydrocarbon concentrations on dredged cuttings were similar to those on undisturbed cuttings, and while levels of alkylphenol ethoxylates and barium were higher in the dredge-recovered water at the platform topsides, hydrocarbon levels in the water remained low, indicating that the majority of hydrocarbons remained bound to the cuttings and did not become free in the dredged water;
    - Corroborating the above, hydrocarbons were not increased significantly in the seawater samples from monitoring stations as a result of the dredging, and there was no detectable oil in the plumes generated during the trial; and
    - There were no visible indications of an oil sheen at the surface, and little discernible effect was seen in the water column more than 100 m from the dredging operations.
- Use of high-pressure water jets to clear oil-based mud cuttings from the Hutton Tension Leg platform, causing significant re-suspension of cuttings, had no major effect on the spatial distribution of cuttings contamination, or on biological communities located more than 100 m from the original platform location.

These observations indicate that extensive disturbance of North Sea cuttings piles has tended to result in limited spreading of contaminated material to the seabed surrounding the cuttings piles, and limited discernible environmental impacts. The investigations at North West Hutton and the Hutton Tension Leg platform suggest that release of hydrocarbons into the water column from disturbed drill cuttings is minimal, and the majority of hydrocarbons present would remain bound to the cuttings (OSPAR, 2009a). Based on these conclusions, the likely impact of disturbance to the Dunlin Alpha installation drill cuttings pile is assessed below.

Fugro (2017, 2018) indicate that the drilling fluids present around the Dunlin Alpha installation are a mixture of diesel, low toxicity oil based fluids and synthetic fluids. Toxicity of synthetic-based mud to benthic organisms is, as summarised by Neff *et al*. (2000), generally low. Neff *et al*. (2000) conclude that a proportion of observed harmful effects are probably due to nutrient enrichment and subsequent anoxia in affected sediments. Hydrocarbon concentrations in the surface layer of the Dunlin cuttings pile range from average 300 μgg^{-1} to 146,000 μgg^{-1}. These concentrations exceed the concentrations expected to cause toxic effects on the benthos (Neff *et al*. 2000, OSPAR, 2006). The term ‘total hydrocarbon content’ incorporates all types of hydrocarbon material, and toxic effects vary widely within the hydrocarbon grouping. Groups that tend to cause toxicity include PAHs. The OSPAR Coordinated Environmental Monitoring Programme (CEMP) identified nine PAHs of specific concern. Fugro (2018) reported that maximum concentrations of these nine PAHs across the cuttings at the Dunlin Alpha installation typically exceeded Effects Range Low (ERL) concentrations, indicating toxic effects may be expected. Trace element (heavy metal) concentrations were also generally elevated above ERL concentrations. These results from the surface of the cuttings accumulation were generally in line with those from other North Sea cuttings accumulations.

5.3.2.4. Environmental Vulnerability to Drill Cuttings Disturbance

Benthos

The macrofaunal community of the cuttings pile at the Dunlin Alpha installation is considered to be impoverished, with reduced numbers of taxa and a high abundance of the hydrocarbon-tolerant *Capitella* sp. (Fugro, 2018). Statistical analysis indicated that proximity to the cuttings pile and variation in sediment particle size, sediment lithium content and total hydrocarbon content best explained the variation in the benthic community (Fugro, 2018). These results suggested that the cuttings have the potential to impart toxic impacts if spread outside the existing accumulations by decommissioning activities, and this is borne out by the modelling results (both the spatial distribution and the sediment EIF, which shows the majority of the risk is presented by the chemical constituents of the pile). Outside of the actual cuttings accumulations, the macrofaunal community was similar to that found in the wider area, and the majority of the dominant species were considered to be hydrocarbon intolerant (Fugro, 2018). This suggests that the faunal community surrounding the cuttings pile is reasonably stable and tolerant of the contaminants in the area. It is therefore likely that re-settling of small amounts of cuttings around the fringes of the existing accumulation will not cause community level changes through toxicity. Again, this is reflected in the limited spatial extent of the predicted impact from cuttings redistribution.

As such, whilst disturbance of the accumulation is predicted by modelling to distribute contaminated material over a small additional area, it is deemed unlikely to result in significant toxic effects beyond that which will be experienced by individuals, especially when considering that large scale disturbance events (such as the Hutton Tension Leg platform operations described above) have been found to have no major effect on the spatial distribution of cuttings contamination, or on biological communities located more than 100 m from the disturbance location (OSPAR, 2009a).

IOGP (2016) reports a threshold drilling fluid/cuttings burial depth causing mortality of benthic organisms of 6.5 mm. Modelling suggested that disturbance of the Dunlin Alpha cuttings pile could cause burial of the benthos to depths greater than 6.5 mm within a few hundred metres of the Dunlin Alpha installation. There may be some impact on the benthos from burying if a sufficiently large disturbance event occurs, but this is expected to be local, and recovery is expected to being around a year following the disturbance event (as supported by the one off nature of the redistribution and of the rapidly declining sediment EIF). This is supported by the presence of a benthic community near to the Dunlin Alpha installation (but not on the cuttings pile itself) that is representative of the wider area, despite being routinely subjected to oil-based drill cuttings discharges up until 2001.

In addition to toxicity and burial, drill cuttings can impact the benthos through anoxia caused by a combination of organic enrichment (which increases the biochemical oxygen demand) and introduction of fine sediments (which restricts oxygen penetration into sediments). The survey field logs indicate the grab samples from the cuttings accumulation were anoxic below the surface, with a characteristic odour of hydrogen sulphide. Laboratory analysis showed that the Total Organic Matter (TOM) content of the samples taken from the surface of the cuttings accumulation was elevated compared to samples taken outside the cuttings accumulation. Cuttings material that re-settles following a re-suspension by a disturbance event is likely to be fine, and unconsolidated (since coarser and/or consolidated material is unlikely to be re-suspended). It will settle gently and therefore there is likely to be oxygenated water in the pore spaces initially. It is not expected to form an effective barrier to oxygen penetration from the surrounding seawater. In addition, the act of re-suspension is likely to partially re-oxygenate the material. Outside of the deeper areas of cuttings re-settlement, the infauna is expected to burrow back to the surface and assist in re-working the sediment. OSPAR (2009a) suggests that spreading of cuttings material will encourage aeration and degradation of cuttings material. Whilst there is potential for cuttings disturbance to promote organic enrichment in the surrounding sediments, the scale of this impact is expected to be limited and is not expected to cause anoxic conditions. The amount of material that will be re-distributed is unlikely to be sufficient to produce an effective oxygen barrier between the seabed and the surrounding seawater, or to prevent infauna from reaching the surface and re-working the sediment. The sediment EIF development (Figure 5.4) appears to corroborate this, showing almost no contribution to impact from lack of oxygen.

In conclusion, the small amount of material likely to be moved outside the existing cuttings accumulation area, the tolerance of the fauna to low levels of toxicity, and the limited potential for smothering and anoxia suggest there will be no significant impacts on the benthos from disturbance of the cuttings accumulation that is predicted by the modelling.

Plankton

IOGP (2016) cites a number of sources indicating the impacts of drill cuttings discharge on plankton are negligible. Recorded deleterious effects on phytoplankton are generally attributed to light attenuation due to suspended solids. The majority of the disturbed material is expected to re-settle almost immediately, and material disturbed at the seabed is predicted by the modelling to be unlikely to interact with the photic zone (Figure 5.6). No impact on plankton is therefore expected.

Fish

Neff *et al*. (2000) reports that synthetic-based fluids have very low toxicity to fish, and do not bioaccumulate meaning there is no risk of SBM being concentrated in the food chain. The diesel and LTOBM material may be toxic since many of the toxic components (such as aromatics) remain present at levels exceeding ERL concentrations. However, OSPAR (2009a) indicates that hydrocarbons are likely to remain bound to sediments rather than become free in the water column and therefore pathways for toxic components into fish are likely to be limited. The most significant effect on fish is interference with feeding behaviour due to increased sediment load in the water column. Impact from increased sediment load as a result of the proposed activities is predicted by the modelling to be short-term (likely to peak at a maximum of around 5 days after the disturbance event).

Seabirds

The most familiar effect of oil pollution on seabirds is the contamination of plumage, resulting in flightlessness and lack of insulation, compounded by ingestion of toxins through preening during attempts to remove contamination. The decommissioning of the Hutton Tension Leg platform and the large-scale disturbance of the cuttings accumulation resulted in no visible surface sheen. The modelling of Dunlin Alpha installation drill cuttings disturbance indicated that disturbed sediments and associated contaminants would remain within the lower portion of the water column (Figure 5.6) beyond the diving capability of most seabirds. No impact on seabirds is therefore expected.

Marine Mammals

There is little published data available on the impacts of synthetic-based fluids on marine mammals. The available data on other fauna suggests that synthetic-based fluids are low in toxicity and non-bioaccumulating. Fugro (2018) indicates toxic components of the diesel and LTOBM are still present at concentrations exceeding

ERL. Since the majority of the drilling fluid disturbed by the proposed activities is expected to remain bound to the drill cuttings particles, which are expected to re-settle close to the original cuttings accumulation (as shown in Figure 5.3), marine mammals in the area will experience minimal exposure. Furthermore, suspended material is expected to remain in the lower portion of the water column (Figure 5.6) and to settle quickly following disturbance (no further impact will be exerted to the water column after 14 days). Therefore, no impact on marine mammals is expected.

5.3.3. Mitigation Measures

The following mitigation measures have been identified to limit potential impact from drill cuttings disturbance:

- A navaid will be installed on top of one of the steel transitions to visibly show the location of the structure and drill cuttings to other sea users. Cathodic protection will be installed and coatings applied to reduce corrosion rates;
- Standard notifications and notice to mariners will detail the presence of the drill cuttings and associated 500 m safety zone;
- Admiralty charts and the Fishsafe system will be updated to show the location of the drill cuttings; and
- Retention of the 500 m safety zone. This will exist until the point that the surface structures have collapsed below the water line, at which point FEL will make an application to renew the safety zone for a subsea structure.

5.3.4. Cumulative Impact Assessment

It is important to consider the potential for impact to arise from unplanned disturbance of the drill cuttings in conjunction with similar events occurring as part of other projects or activities in the area. Given the limited spatial extent of the drill cuttings distribution and the extremely limited depth of deposition, settling of disturbed cuttings will not occur with sufficient depth to accumulate on existing cuttings piles from other assets. There will likely be disturbance of other drill cuttings in the wider northern North Sea in the coming years during which the Dunlin Alpha cuttings pile persists. Assuming redistribution of such cuttings occurred with a similar extent as predicted for Dunlin Alpha, sediment deposition would be unlikely to extend as far as the footprint of the Dunlin Alpha cuttings pile. It is therefore considered that cumulative impacts will not arise from concurrent or sequential disturbance of drill cuttings.

In addition, significant cumulative impacts resulting from the disturbance of drill cuttings and a release of cell contents, as a result of an early transition failure, are unlikely to occur. The drill cuttings pile provides protection for the CGBS cell contents, acting as a buffer to absorb the energy impact and prevent or limit the extent of a loss of containment. The potential for impacts resulting from disturbance of the drill cuttings pile will also be significantly reduced by the time of the anticipated transition failure.

Decommissioning of the Dunlin Alpha installation may overlap temporally and geographically with subsea decommissioning activities in the Dunlin, Merlin and Osprey area. The overlapping execution of these projects will result in higher than normal vessel densities in the area, increasing the risk of a dropped object hitting the drill cuttings. Mitigation measures, including identification and management of simultaneous operations (SIMOPS) and use of Automatic Identification System, are considered to reduce this additional risk to as low as reasonably practicable.

5.3.5. Transboundary Impact Assessment

Disturbed drill cuttings will not cross the transboundary line (11 km to the east) and there will therefore be no transboundary impact.

5.3.6. Protected Sites and Species

5.3.6.1. Protected Sites

As outlined above, disturbance of the drill cuttings will result in spatially limited potential impacts and, given the location of the Dunlin Alpha installation, no impacted on protected sites is expected.

5.3.6.2. Protected Species

The ocean quahog is on the OSPAR list of threatened or declining species and is a PMF. This species is known to occur in the area at low densities as detailed in Section 4, although the area is not thought to be particularly important for the species. Ocean quahog is a benthic species, and therefore there is the potential for slight impact in the event of a drill cuttings release. However, the volumes are small and as detailed in Section 4.3.1, there are found to be limited numbers of ocean quahog in the area, it is considered unlikely that any disturbance of the drill cuttings would have a significant impact on the ocean quahog population in the area.

5.3.7. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Benthos	Low	Low	Low	Minor
Other features of the seabed, water column and sea surface	Low	Low	Low	Minor
Rationale				
Direct impacts may occur in the event of a release such as impacts to benthic species, those in the water column and oiling of seabirds at the surface. Impacts are expected to be short-term and local, although there is a low probability of a localised transboundary impact. The frequency of the impact is expected to be a one-off. The likelihood of an instantaneous release of drill cuttings through disturbance is considered very low. The likelihood that the receptors (benthic species and seabirds) will be in the area in the event of a release is considered high, although the number of seabirds present is expected to be low during most months. Taking this into account, the impact magnitude for benthos and other marine receptors is minor. Data on sensitivity of the dominant benthic species present in the area is sparse, but there is good data on the sensitivity of the biotope complexes present. Biotope tolerance (resistance) to direct disturbance ranges from medium to low and ability to recover or adapt ranges from high to medium. Tolerance is therefore characterised as low and ability to recover as medium, giving a receptor sensitivity of low. The impact is not likely to affect long term function of the benthic system or the status of the benthic population. There				

will be no noticeable long-term effects above the level of natural variation experienced in the area. Receptor vulnerability is therefore deemed to be low. The impact area contains small numbers of ocean quahog, which is listed on the OSPAR (2008) List of threatened and declining habitats and species. However, only three juvenile individuals were identified in three of the 30 grab samples recovered from the area, indicating the area is not currently important for the species. Apart from ocean quahog there is no specific value or concern about the site, which supports biotopes that are abundant across the wider area. The value of the receptor is therefore deemed to be negligible. The impact is expected to be temporary, with recovery occurring relatively quickly. The seabed in the area is reasonably homogenous, and the available habitat is extensive, with any potential impact affecting a small proportion of the total available habitat. The geographical extent of the impact is therefore deemed to be local.	
Consequence	**Impact significance**
Low	Not significant

5.4. Physical Presence

5.4.1. Overview

The Dunlin Alpha decommissioning activities have the potential to impact upon other users of the sea. This may happen during the decommissioning activities themselves, when vessels are working in the field and transiting to shore occupy space, and after decommissioning should any infrastructure decommissioned *in situ* interact with activities such as fishing. The main long-term interaction with other users of the sea will be as a result of a 500 m safety zone that will remain around the Dunlin Alpha CGBS, which is proposed to be decommissioned *in situ*. The 500 m safety zone will see the continued exclusion of fisheries from the immediate area around the CGBS.

5.4.2. Description and Quantification of Potential Impact

Fairfield expects that the existing 500 m safety zone around the CGBS will remain in place up to the point that the surface structures have degraded and fallen through the water column. As this is not likely to occur for the next 250 years, this will effectively mean permanent exclusion of other users of the sea (shipping and fishing) from an area of approximately 0.8 km^2. Should the surface structures collapse below the water line much earlier than anticipated, an application would be made to renew the 500 m safety zone for a subsea structure.

It should be noted that the maintenance of the 500 m safety zone will limit any potential interactions with the remaining structure and drill cuttings, effectively eliminating snag risk and possible tainting of catch.

5.4.3. Mitigation Measures

There are several mitigation measures that Fairfield will have in place to limit the potential for interaction with fisheries and other users of the sea in the longer-term:

- Standard notifications and notice to mariners will detail the presence of the structure and the associated 500 m safety zone;

- Admiralty charts and the FishSafe system will show the permanent location of the Dunlin Alpha CGBS, and Kingfisher Bulletin and Notices to Mariners will be updated;
- A navaid will be installed on top of one of the steel transitions to visibly show the location of the structure and drill cuttings to other sea users. Cathodic protection will be installed and coatings applied to reduce corrosion rates;
- Regular inspection and replacement of the navigational aid and an aerial inspection of the CGBS will be undertaken on a 4-yearly basis.

5.4.4. Cumulative Impact Assessment

In terms of the scale of leaving the 500 m safety zone in place with regards to fisheries, there are estimated to be 457 safety zones in the central and northern North Sea on the UKCS (UKOilAndGasData, 2016). This equates to approximately 360 km^2 of sea area being occupied by safety zones, which is insignificant when compared to the entire Northern North Sea fishing area. Additionally, many of these will be returned as navigable waters of the North Sea during decommissioning planning for those assets. This will assist in reducing the areas of the North Sea currently unavailable to fisheries and thus in reducing the potential for cumulative impact from decommissioning of North Sea structures. The small area of sea that would remain out of bounds to fisheries, especially in the context of the limited fishing effort in the Greater Dunlin Area, as a result of the Dunlin Alpha installation remaining *in situ* is not therefore likely to present a significant cumulative impact.

It should be noted that a number of subsea safety zones associated with the Greater Dunlin Area Decommissioning Project will be removed after decommissioning (e.g. for the Merlin and Osprey fields).

5.4.5. Transboundary Impact Assessment

As the Dunlin Alpha installation is located beyond the UK's 12 nm limit, EU and non-EU vessels are also permitted to fish in the area[11], subject to management agreements including, for example, quota allocation and days at sea. Xodus (2016) report vessels of Norwegian origin to be present in the Greater Dunlin Area (up to 50% of vessels). Of the demersal trawlers actively fishing in the study area 38% were of Norwegian origin. It was also seen that the majority (64%) of vessels crossing the subsea infrastructure were of Norwegian origin with an average of 0.18 subsea infrastructure crossings occurring each day by Norwegian vessels (Xodus, 2016). Despite this, the vessel presence is still regarded as relatively low, and there is no mechanism by which significant transboundary impacts could occur.

---

[11] Note that arrangements may change post-Brexit.

5.4.6. Residual Impact

Receptor	Sensitivity	Vulnerability	Value	Magnitude
Other sea users	Negligible	Low	Low	Minor
Rationale				
The information in the Environment Description (Section 4) has been used to assign the sensitivity, vulnerability and value of the receptor as follows. There has been a safety zone around the Dunlin Alpha installation for over 40 years, and fishing in the much wider Greater Dunlin Area is not high (as discussed in Section 4.5.1). As a result, sensitivity is deemed negligible. The vulnerability has been ranked as Low as there is no change to the exclusion in the area. On the basis of the estimated catch values from the area around the Dunlin Alpha installation, the value is defined as Low. There will be continued localised exclusion from the area (approximately 0.8 km^2), the magnitude is considered to be Minor. Combining these rankings, the impact significance is defined as negligible and thus not significant.				
Consequence		**Impact significance**		
Low		Not significant		

5.4.7. Positive Effects of Physical Presence

There is the potential for the decommissioning of infrastructure *in situ* resulting in an artificial reef which has the potential to be used as a sheltered area for fish species.

Installations of oil and gas platforms across the North Sea have introduced substantial amounts of hard substrate to the seafloor. These structures promote dense growth of hard-bottom marine organisms: including algae, mussels, tube-building worms, hydroids, anemones and reef-building corals all colonise these platforms from the top of the platform jacket down to the footings resting at the depths of the seafloor, this results in the platforms functioning as “artificial reefs”. The INSITE ANChor project, carried out by the University of Edinburgh (Henry, *et al*., 2017), has been undertaking research to establish the magnitude of effects these man-made structures have had in creating a larger inter-connected hard substrate reef system, current tests of this concept suggest connectivity varies across North Sea regions. According to ANChor modelling results, Dunlin Alpha was a potential larvae "donor" to seven other oil and gas structures, and has a potential role in creating a network of coral ecosystems.

5.5. Waste

5.5.1. Project-Specific Challenges

The main challenges associated with waste management for the Dunlin Alpha decommissioning project include:

- The generation of large quantities of controlled waste within a short period of time which will require 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 hazardous materials to be generated. This can be due to contamination of existing process equipment or due to the cross–contamination of non-hazardous waste with substances that have hazardous properties. This will result in an increase in the overall

volume of waste 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; and

- The problems 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.

5.5.2. Duty of Care

The duty of care with regards to appropriate handling and disposal of waste from the Dunlin Alpha installation rests with Fairfield. To enable Fairfield to manage waste appropriately, it is necessary to understand the regulations under which waste is handled and the key sources of waste. Section 5.5.3 describes the regulatory control of waste material whilst Section 5.5.4 outlines the types of waste material that will be generated as a result of the proposed decommissioning activities. Section 5.5.5 details the measures that will be in place to ensure waste is appropriately managed.

5.5.3. Regulatory Control

The EU's Revised Waste Framework Directive (Directive 2008/98/EC) was adopted in December 2008. The aim of the Directive is to ensure that waste management is carried out without endangering human health and without harming the environment. Article 4 of the Directive also states that the waste hierarchy shall be applied as a priority order in waste prevention and management legislation and policy.

The Waste (Scotland) Regulations 2012 control the generation, transportation and disposal of waste within the European Union and the shipment of waste into and out of the EU. It covers controlled waste, duty of care, registration of carriers and brokers, waste management licensing, landfill, hazardous waste, producer responsibility, packaging waste, end-of-life vehicles, waste electrical and electronic equipment and the trans-frontier shipment of waste.

Whether a material or substance is determined as a 'waste' is determined under EU law. The Waste Framework Directive defines 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". Materials disposed of onshore must comply with the relevant health and safety, pollution prevention, waste requirements and relevant sections of the Environmental Protection Act 1990. Management of radioactive materials is governed under the Radioactive Substances Act 1993, Trans-frontier Shipment of Radioactive Waste and Spent Fuel Regulations 2008. The handling and disposal of radioactive waste requires additional authorisation. Onward transportation of waste or recycled materials must also be in compliance with applicable legislation, such as the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009, a highly prescriptive regulation governing the carriage of dangerous goods by road.

5.5.4. Sources of Waste

Detailed inventory assessments have been undertaken in order to characterise and quantify both hazardous and non-hazardous materials to be decommissioned. Where required, this has involved specific sampling and analysis by competent specialists in order to ensure materials are classified correctly. A summary of the types of material on the Dunlin Alpha installation is provided in Table 5.5. Full details of the materials inventory is available in the Dunlin Alpha Draft Decommissioning Programme (Fairfield, 2018b), and will managed as a live inventory within Active Waste Management Plans developed for the project.

Table 5.5 Summary of Materials Being Removed from the Dunlin Alpha Installation

Item	Description	Location (s)
Non-hazardous materials		
Ferrous metals	Carbon steel; stainless steel; titanium, cast iron	Structural steel; piping; bulk tanks; machinery; equipment
Non-ferrous metals	Copper; aluminium; nickel; zinc	Copper wiring, aluminium
Plastic	PVC/uPVC; rubber	Piping; hoses; insulation
Concrete	Concrete; cement	Structural/construction material
Wood	Wood	Construction material; furniture
Marine growth	Marine growth	Conductors; Conductor Guide Frames
Hazardous materials		
Bulk liquids	Hydrocarbons; process chemicals; sludge	Bulk tanks; pipework; equipment
Heavy metals	Mercury; lead; cadmium	Batteries; paint coatings; light-fittings; Waste Electrical and Electronic Equipment
Radioactive material	NORM	NORM (Scale, sediments, sludge); smoke detectors
Asbestos	Asbestos; asbestos containing material	Gaskets, cladding; work tops

5.5.5. Management of Waste

Environmental management of the Dunlin Alpha Decommissioning Project activities will include waste management as a key factor in limiting potential environmental impact. Management of waste will therefore be dealt with in accordance with Fairfield's EMS, certified to the international standard ISO 14001:2015.

As operator of the Dunlin Alpha installation, Fairfield recognises its duty of care for all waste materials generated from the forthcoming decommissioning activities. As a result, Fairfield must consider the complete life cycle of decommissioning waste, including:

- Waste identification;
- Offshore treatment and storage;
- Offshore preparation/cleaning;
- Shipment of waste;
- Onshore deconstruction;
- Onshore transportation;
- Final disposal/recovery; and
- Ongoing monitoring.

To this end, Fairfield has developed a waste management strategy for the project in order to outline the processes and procedures necessary to ensure that waste is managed in a manner that complies with legislative requirements and prevents harm to people and the environment (Fairfield, 2017b).

The waste management strategy provides guidance on waste management options and details project requirements for the successful management of decommissioning waste, including:

- Development of detailed materials inventory;
- Use of competent waste contractors and appropriately licensed sites;
- Contractors to develop and implement Active Waste Management Plans;
- Documentation requirements (i.e. waste transfer notes, disposal certificates);
- Targets for reuse, recycling and disposal;
- Regular engagement with waste regulators; and
- Assurance audits of disposal yard and contractor waste management systems.

Fairfield's waste management strategy is underpinned by the waste hierarchy, shown in Figure 5-9. The hierarchy is based on the principle of waste disposal only where reuse, recycling and waste recovery cannot be undertaken.

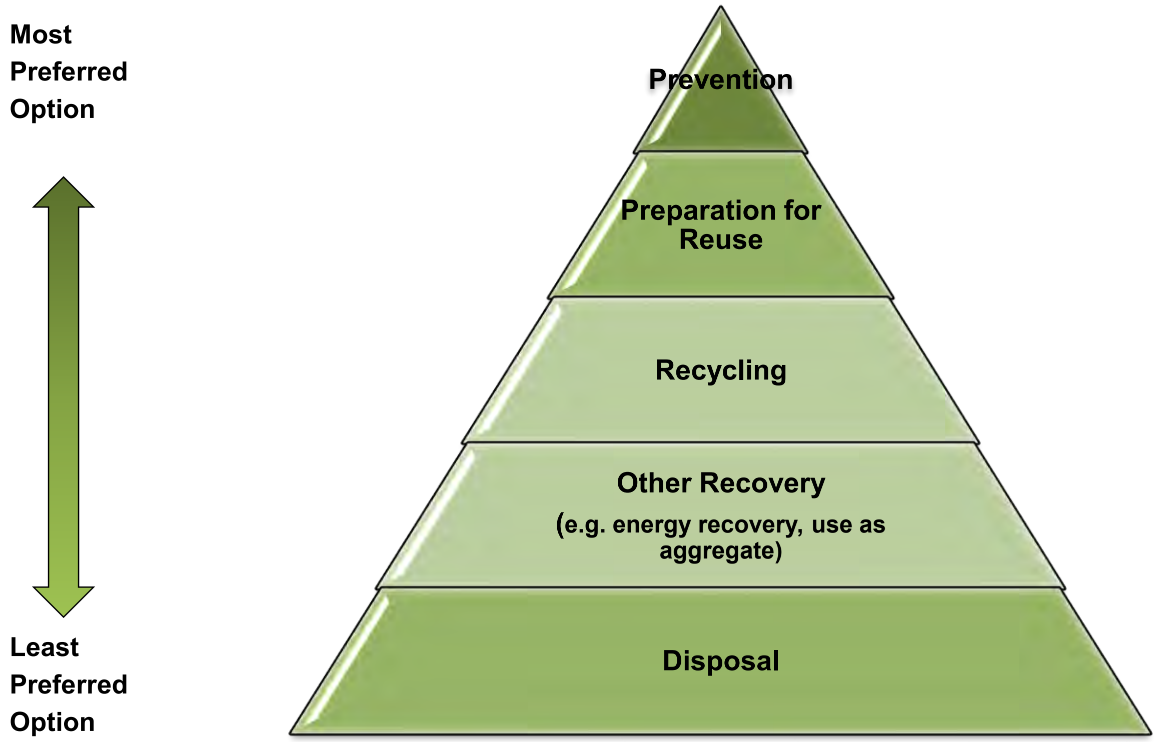


Figure 5.8 Waste Hierarchy

Steel and other recyclable metal are estimated to account for the greatest proportion of the materials to be removed to shore. Typically, around 95% of the materials from decommissioning projects can be recycled (OGUK, 2017). OGUK (2018) report that of the 7,289 tonnes of waste brought onshore from decommissioning projects in 2016, 91% was reused, recycled or used for power generation. Given that much of the material to be returned to shore from the decommissioning of the Dunlin Alpha installation will be recyclable (primarily topsides, MSF and conductors), it is expected the same high proportion of recycling will be true for the Dunlin Alpha Decommissioning Project. A summary of Fairfield's waste management aspirations for material brought to shore is given in Table 5.6

Table 5.6 Waste Management Aspirations

Waste stream	Reuse	Recycle	Other recovery	Landfill
Ferrous metal	0 - 15%	95 - 98%	0%	0 - 5%
Non-ferrous metal	0%	95 - 98%	0%	0 - 5%
Concrete (aggregates)*	0 - 50%	0%	50 - 100%	0 - 25%
Plastics	0%	50 - 75%	15 - 40%	0 - 10%
Residual hydrocarbons	0%	0%	85 - 100%	0 - 15%
NORM	0%	0%	0%	100%**
Marine growth	0%	0%	75 - 100%	0 - 25%

** Reuse/recovery opportunities will be dependent on availability of infrastructure projects*

*** NORM may be sent for incineration prior to landfill in order to reduce volume*

For materials where reuse or recycling is not an option, these will be sent to an appropriately licensed disposal facility for recovery, or landfill where no other options are viable. In terms of the waste hierarchy, recovery is more beneficial than landfill since it means a waste product is used to replace other materials that would otherwise have been used to fulfil a particular function.

Preparation of Dunlin Alpha infrastructure for removal may result in the generation of special waste streams as equipment is flushed and isolated. Such wastes will be disposed of under an approved regulatory permit, as required, and in accordance with Dunlin Alpha Safe Operating Procedures and the Fairfield Waste Management Strategy, with consideration of specific sampling, classification, containment, and consignment conditions. It is likely that there will be small volumes of residual hydrocarbons, chemicals and naturally occurring radioactive material in some equipment recovered to shore. Any special wastes remaining in recovered infrastructure will be disposed of under an appropriate license or permit.

As stated in Section 2.3.3.5, the majority of marine growth will removed offshore. Any marine growth that is transferred to shore will be managed by an appropriately licensed dismantling facility. Options for the disposal of marine growth include composting, land spreading or landfill.

A key factor in the successful execution of Dunlin Alpha Decommissioning Programme will be the selection of a competent decommissioning contractor and suitable decommissioning facility. Once a decommissioning contractor has been selected, an Active Waste Management Plan and project interface documents will be developed in order to address all Fairfield decommissioning project requirements, agree waste management objectives, and establish project assurance and reporting protocols.

The Active Waste Management Plan will detail the measures in place to ensure all permits and licenses are in place for the handling and disposal of the waste types identified, and that all waste is transferred by an appropriately licensed carrier. The selected contractor will be required to maintain a waste audit trail through to recycling or disposal facility. The Active Waste Management Plan will be kept under constant review and appropriately updated throughout execution of the decommissioning project.

6. Conclusions

Following review of the activities associated with the Dunlin Alpha Decommissioning Project, the environmental sensitivities of the project area, industry experience with decommissioning activities and of stakeholder concerns, it has been determined that assessment of the following issues was required in order to properly define the potential impact of the Dunlin Alpha Decommissioning Project activities:

- The gradual release of cell contents as the CGBS degrades over time;
- An event resulting in an instantaneous release of the cell contents;
- An event resulting in disturbance of the drill cuttings pile;
- Loss of access by the permanent presence of the CGBS decommissioned *in situ;* and
- The management of waste associated with the decommissioning activities at the Dunlin Alpha installation.

A review of each of these potentially significant environmental interactions has been completed and, considering the extent of potential interaction with receptors and the mitigation measures that will be built into Project activities, there is expected to be no significant impact on receptors. As part of this review, cumulative and transboundary impacts have been assessed and determined to be not significant. The information used to undertake the assessments is based on evidence gather from operational records, analysis of historical records, analogous data and / or the application of proven scientific principles. Uncertainties associated with the base data have been assessed and where appropriate, conservative (worst-case) assessments have been applied to ensure environmental impact is not underestimated.

The Dunlin Alpha installation is located a substantial distance from designated sites; the closest is the Pobie Bank Reef SCI, designated due to the presence of reefs, which is 98 km to the southwest. Consideration of the potential impact on protected sites in the wider vicinity has been considered in the assessment. Having reviewed the Project activities, there is not expected to be a significant impact on any protected sites.

Finally, this Environmental Appraisal has considered the objectives and marine planning policies of the National Marine Plan across the range of policy topics including biodiversity, natural heritage, cumulative impacts and oil and gas. Fairfield considers that the proposed decommissioning activities are in broad alignment with such objectives and policies.

In summary, the proposed operations have been rigorously assessed through the Environmental Appraisal process (and in some cases, also the Comparative Assessment process), resulting in a set of selected decommissioning options which are thought to present the least risk of environmental impact whilst satisfying safety risk, technical feasibility, societal impacts and economic requirements. Based on the findings of this Environmental Appraisal and the identification and subsequent application of the mitigation measures identified for each potentially significant environmental impact (which will be managed through Fairfield's EMS), it is concluded that the proposed activities will result in no significant environmental impact.

7. References

Aires, C., Gonzlez-Irusta, J.M. and Watret, R. (2014). Scottish Marine and Freshwater Science Report, Vol 5 No 10, Updating Fisheries Sensitivity Maps in British Waters' found at: http://www.scotland.gov.uk/Publications/2014/12/3334 with further details online at http://www.scotland.gov.uk/Topics/marine/science/MSInteractive/Themes/fish-fisheries/fsm [Accessed 17/02/2017].

ARPS (2018). Dunlin Alpha Decommissioning – CGBS Radiological Impact Assessment (ARPS-DUN-GBD-RPT-00001).

Atkins (2017a). Dunlin Alpha Platform Decommissioning – CGBS Studies for Comparative Assessment. Study 5 – Aids for Navigation. 5153952-REP-ST-005-001.

Atkins (2017b). Dunlin Alpha Platform Decommissioning – CGBS Studies for Comparative Assessment. Study 8 – Leg Failure. Report for Fairfield Betula Ltd. Revision A4, 6th November 2017.

BEIS (2018). Guidance Notes - Decommissioning of Offshore Oil and Gas Installations and Pipelines.

BODC (1998). United Kingdom Digital Marine Atlas. An atlas of the seas around the British Isles, British Oceanographic Data Centre, NERC.

Brussaard, C., Peperzak, L., Beggah, S., Wick, L.Y., Wuerz, B., Weber, J., Arey, J.S., van der Burg, B., Jonas, A., Huisman, J. and van der Meer, J.R. (2016). Immediate ecotoxicological effects of short-lived oil spills on marine biota. Nature Communications: 2016 Apr 4;7:11206. Online at: http://www.nature.com/articles/ncomms11206 [Accessed 15/02/2017].

Coull, K.A., Johnstone, R. and Rogers, S.I. (1998). Fisheries Sensitivity Maps in British Waters. UKOOA Ltd., London.

De-Bastos, E.S.R. (2016). Amphiura brachiata with Astropecten irregularis and other echinoderms in circalittoral muddy sand. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Online at http://www.marlin.ac.uk/habitat/detail/1079 [Accessed 26/01/2017].

DECC (2016). UK Offshore Energy Strategic Environmental Assessment. OESEA3 Environmental Report. Future Leasing/Licensing for Offshore Renewable Energy, Offshore Oil & Gas, Hydrocarbon Gas and Carbon Dioxide Storage and Associated Infrastructure. Online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/504827/OESEA3_Environmental_Report_Final.pdf [Accessed 28/02/2017].

Decom North Sea (2017). Environmental Appraisal Guidelines. Online at http://decomnorthsea.com/about-dns/projects-update/environmental-appraisal-guidelines [Accessed 08/12/2017].

Ellis, J.R., Milligan, S., Readdy, L., South, A., Taylor, N. and Brown, M. (2012). Mapping the spawning and nursery grounds of selected fish for spatial planning. Report to the Department of Environment, Food and Rural Affairs from Cefas. Defra Contract No. MB5301.

Fairfield (2016). Dunlin Alpha Decommissioning Option Screening for Comparative Assessment, Doc. No.: FBL-DUN-DUNA-HSE-01-PLN-00003, Rev.: A1, Dated: 20/10/16.

Fairfield (2017). Dunlin Subsea Decommissioning Environmental Statement. XOD-DUN-HSE-RPT-00003.

Fairfield (2017b). Fairfield Waste Management Strategy. Document No. FBL-DUN-HSE-STR-00003.

Fairfield (2018a). Dunlin Alpha Comparative Assessment Report. Document No. A-301649-S07-REPT-005.

Fairfield (2018b). Dunlin Alpha Decommissioning Programme. Document No. FBL-DUN-DUNA-HSE-01-PLN-00001.

Fairfield (2018c). Dunlin Alpha CGBS – Cell Contents Technical Report. Document No. FBL-DUN-DUNA-FAC-24-RPT-00001.

Fairfield (2018d). Dunlin Alpha Decommissioning Project Stakeholder Engagement Report. Document No. FBL-DUN-DUNA-FAC-01-RPT-00006.

Fugro (2001). Wind and wave frequency distributions for sites around the British Isles, Offshore technology report 2001/030. Online at http://www.hse.gov.uk/research/otopdf/2001/oto01030.pdf [Accessed 30/06/2016].

Fugro (2016a). Fairfield Pre-decommissioning Habitat Assessment Survey Report: Dunlin Field November 2015 to April 2016.

Fugro (2016b). Fairfield Pre-decommissioning Habitat Assessment Survey Report: Dunlin Fuel Gas Import Pipeline November 2015 to April 2016.

Fugro (2016c). Dunlin Alpha Fuel Gas Import Pipeline Pre-decommissioning Environmental Baseline Survey Report UKCS 211/23 November 2015 to April 2016.

Fugro (2016d). Fairfield Pre-decommissioning Habitat Assessment Survey Report: Dunlin A to Brent C Power Import Cable Route November 2015 to April 2016.

Fugro (2016e). Dunlin Alpha Power Import Cable Route Pre-decommissioning Environmental Baseline Survey Report UKCS Block 211/23 November 2015 to April 2016.

Fugro (2017). Dunlin Alpha Pre-decommissioning Environmental Baseline Survey Report UKCS Block 211/23 November 2015 to April 2016.

Fugro (201). Dunlin Alpha Pre-decommissioning Cuttings Assessment Survey UKCS Block 211/23, 21st November 2015 to 12th April 2016. Fugro Project No: 160120_15Rev6. Report to Fairfield Energy Limited.

Furness, R.W. (2015). Non-breeding season populations of seabirds in UK waters: Population sizes for Biologically Defined Minimum Population Scales (BDMPS). Natural England Commissioned Reports, Number 164.

Gardline (2009). 2008 UKCS 211/23 Dunlin Development Debris Clearance, 'Mud Mound' and Environmental Baseline Survey. Report Ref: 7859.

Gardline (2010a). Dunlin to NLGP Pipeline Route Survey UKCS Block 211/24 August/November 2009 and April/May 2010; Survey report. Report Ref 8371.

Gardline (2010b). UKCS Quad 211 Infield Environmental Survey. November to December 2008 and September to October 2009. Environmental Baseline Report. Report Ref 7860.

Gardline (2011). Dunlin Fuel Gas Import Route Survey and Environmental Survey UKCS Blocks 211/18a and 211/23a August to September 2010; Environmental Baseline Report. Gardline reference 8529.1.

Gass, S. and Roberts, J.M. (2006). The occurrence of the cold-water coral *Lophelia pertusa* (Scleractinia) on oil and gas platforms in the North Sea: Colony growth, recruitment and environmental controls on distribution. *Marine Pollution Bulletin* **52** (5) 549-559.

Gubbay, S. and Earll, R. (2000). Review of literature on the effects of oil spills on cetaceans. Scottish Natural Heritage Review No. 3. Online at: http://www.snh.org.uk/pdfs/publications/review/003.pdf [Accessed 15/02/2017].

Hammond, P.S., Gordon, J.C.D., Grellier, K., Hall, A.J., Northridge, S.P., Thompson, D. and Harwood, J. (2001). Background information on marine mammals relevant to SEA2. Report to the Department of Trade and Industry. Online at http://www.offshore-sea.org.uk/consultations/SEA_2/TR_SEA2_Mammals.pdf [Accessed 17/02/2017].

Hammond, P.S., Lacey, C., Gilles, A., Viquerat, S., Borjesson, P., Herr, H., Macleod, K., Ridoux, V., Santos, M.B., Scheidat, M., Teilmann, J., Vigada, J. and Oien, N. (2017). Estimates of cetacean abundance in European Atlantic waters in summer 2016 from the SCANS-III aerial and shipboard surveys. Online at https://synergy.st-andrews.ac.uk/scans3/files/2017/04/SCANS-III-design-based-estimates-2017-04-28-final.pdf [Accessed 01/04/18].

Henry, LA., Fox, A., Roberts, M., Polton, J., Adame, CM., Corne, D., Ferris, J., McLellan, F., McCabe, C (2017). ANChor Summary Report. Appraisal of Network Connectivity between North Sea oil and gas platforms. Available online at: https://s3-eu-west-1.amazonaws.com/static.insitenorthsea.org/files/INSITE-ANChor-Summary-Report-v1.0.pdf. [Accessed 20th April 2018].

Hi Def (2016). Sensitivity of offshore seabird concentrations to oil pollution around the United Kingdom: Report to Oil & Gas UK. DOCUMENT NUMBER: HP00061 701.

ICES. 2015. Report of the Benchmark Workshop on North Sea Stocks (WKNSEA), 2–6 February 2015, Copenhagen, Denmark. ICES CM 2015/ACOM:32. 253 pp.

IOGP (International Association of Oil and Gas Producers) (2016). Environmental fates and effects of ocean discharge of drill cuttings and associated drilling fluids from offshore oil and gas operations. Report 543, March 2016. IOGP, London, UK. 144 pp.

JNCC (1999). Block specific seabird vulnerability tables for the UK.

JNCC (2005a). Hermaness, Saxa Vord and Valla Field SPA Site Description. Online at http://jncc.defra.gov.uk/page-1891-theme=default [Accessed 18/01/2017].

JNCC (2005b). Fetlar SPA Site Description. Online at http://jncc.defra.gov.uk/page-1893-theme=default [Accessed 18/01/2017].

JNCC (2011). Memorandum submitted to the House of Commons Energy and Climate Change Select Committee Second Report on UK Deepwater Drilling-Implications of the Gulf of Mexico Oil Spill. Online at: https://www.publications.parliament.uk/pa/cm201011/cmselect/cmenergy/450/450vw03.htm [Accessed 15/02/2017].

JNCC (2013a). Pobie Bank Reef SAC Selection Online at http://jncc.defra.gov.uk/protectedsites/SACselection/SAC.asp?EUCode=UK0030385 [Accessed 17/02/2016].

JNCC (2013b). Third Report by the United Kingdom under Article 17 on the implementation of the Directive from January 2007 to December 2012. Conservation status assessment for Species: S1351 - Harbour porpoise (Phocoena phocoena). Online at http://jncc.defra.gov.uk/pdf/Article17Consult_20131010/S1351_UK.pdf [Accessed 14/02/2017].

JNCC (2016). Faroe-Shetland Sponge Belt MPA. Online at http://jncc.defra.gov.uk/page-6479 [Accessed 18/01/2017]

JNCC (2017). North East Faroe-Shetland Channel MPA. Online at http://jncc.defra.gov.uk/page-6483 [Accessed 18/01/2017].

Kafas, A., Jones, G., Watret, R., Davies, I. and Scott, B. (2012). Representation of the use of marine space by commercial fisheries in marine spatial planning. ICES CM I:23.

MMO (2016). Active vessel numbers and port of landing for UK and non-UK vessels landing from ICES rectangle 51F1 for the period 2010 – 2014. Data requested directly from MMO by Xodus.

Neff, J.M., McKelvie, S. and Ayers Jr, R.C. (2000). Environmental impacts of synthetic based drilling fluids. Report prepared for MMS by Robert Ayers & Associates, Inc. August 2000. U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study MMS 2000-064. 118 pp.

NMPI (2018). Scottish Government Interactive Marine planning tool. Online at https://marinescotland.atkinsgeospatial.com/nmpi/ [Accessed 18/08/2017].

OGUK (2015a). Guidelines for Comparative Assessment in Decommissioning Programmes. SKU: EN038.

OGUK (2015b). Guidelines for the Abandonment of Wells, Issue 5, July 2015. SKU: OP071.

OGUK (2017). Decommissioning insight 2016. Online at http://oilandgasuk.co.uk/decommissioninginsight.cfm [Accessed 14/03/17].

OGUK (2018). Environment Report 2017. Online at https://oilandgasuk.co.uk/environment-report/ [Accessed 16/06/2018].

OSPAR (2005). Agreement on background concentrations for contaminants in seawater, biota and sediment. OSPAR agreement 2005-6. Online at http://www.ospar.org/v_measures/browse.asp [Accessed 17/02/2017].

OSPAR (2006). OSPAR Recommendation 2006/5 on a Management Regime for Offshore Cuttings Piles, Annex 16, Stockholm, 23-30 June 2006.

OSPAR (2008). Case Reports for the OSPAR List of threatened and/or declining species and habitats. OSPAR Commission. Online at: http://qsr2010.ospar.org/media/assessments/p00358_case_reports_species_and_habitats_2008.pdf [Accessed 28/01/2017].

OSPAR (2009a). Assessment of the possible effects of releases of oil and chemicals from any disturbance of cuttings piles. OSPAR Commission, London. Publication number 337/2009 (2009 update). Online at www.ospar.org/documents?d=7082 [Accessed 18/01/2017].

OSPAR (2009b). *Background Document for Lophelia pertusa reefs*. Biodiversity Series. ISBN 978-1-906840-63-1, Publication Number: 423/2009.

OSPAR (2012). CEMP 2011 Assessment Report – Monitoring and Assessment Series.

PhysE (2012). Metocean criteria for the Dunlin Field Volume 1: Design Criteria. Report Ref: R-521-12-F3.

Reid, J., Evans, P.G.H. and Northridge, S. (2003). An atlas of cetacean distribution on the northwest European Continental Shelf. Joint Nature Conservation Committee, Peterbourgh.

Rogers, C.S. (1990). Responses to coral reefs and reef organisms to sedimentation. Marine Ecological Progress Series, 62, 185 – 202.

Russell, D.J.F., Jones, E.L. and Morris, C.D. (2017). Updated Seal Usage Maps: The Estimated at-sea Distribution of Grey and Harbour Seals. Scottish Marine and Freshwater Science Vol 8 No 25, 25pp. DOI: 10.7489/2027-1.

SCOS (2014). Scientific Advice on Matters Related to the Management of Seal Populations: 2014. Online at http://www.smru.st-andrews.ac.uk/documents/2589.pdf [Accessed 01/04/2016].

Scottish Government (2017). Scottish Sea Fisheries Statistics, 2016. Scottish Government. Online at http://www.gov.scot/Topics/Statistics/Browse/Agriculture-Fisheries/RectangleData [Accessed 19/12/2017].

Scottish Government (2011). Scotland's Marine Atlas. Available online at: http://www.gov.scot/Publications/2011/03/16182005/25. [Accessed 15th May 2018].

SMRU (2011). Utilisation of space by grey and harbour seals in the Pentland Firth and Orkney waters. Scottish Natural Heritage commissioned report No. 441.

SNH (2016). Fetlar to Haroldswick NCMPA. Online at https://www.nature.scot/professional-advice/safeguarding-protected-areas-and-species/protected-areas/national-designations/marine-protected-areas/nature-conservation-15 [Accessed 01/04/18].

Sonntag, R.P., Benke, H., Hiby, A.R., Lick, R. and Adelung, D. (1999). Identification of the first harbour porpoise (Phocoena phocoena) calving ground in the North Sea. Journal of Sea Research, 41, 225 – 232.

Tillin, H.M. and Budd, G. (2016). Abra alba and Nucula nitidosa in circalittoral muddy sand or slightly mixed sediment. In Tyler-Walters H. and Hiscock K. (eds) Marine Life Information Network: Biology and Sensitivity Key Information Reviews, [on-line]. Plymouth: Marine Biological Association of the United Kingdom. Online at http://www.marlin.ac.uk/habitat/detail/62 [Accessed 26/01/2017].

UKOilAndGasData (2016). Oil and Gas infrastructure dataset. Online at https://www.ukoilandgasdata.com/ [Accessed 31/07/2017].

UKOOA (2001). An analysis of UK offshore oil and gas environmental surveys 1975-95.

UKOOA (2005). UKOOA JIP 2004 Drill Cuttings Initiative Phase III: Final Report. Report for submission to DTI. Report number 20132900, 26 January 2005.

Xodus (2016). Commercial Baseline Fisheries Report. Document Number: A-301524-S00-REPT-003.

Xodus (2017). Dunlin CA Studies – Marine Growth Assessment. Document Number: A301649-S09-REPT-001.

Appendix A – ENVID Matrix

Aspect	Prepare for leave *in situ* of CGBS, legs and steel transitions	Deconstruct and remove topsides and transfer to shore	Install Navaids	Offshore debris clearance	Legacy	Planned/ Unplanned	Embedded mitigation	Further detailed assessment to be undertaken?	Support for position
1 Energy use and emissions to air									
i) Vessels use	Yes	Yes	Yes	Yes	Yes	P	- Low sulphur diesel - Contractor selection - maintenance programme - MARPOL compliance - Campaign, logistics, sharing vessels (across FEL portfolio) optimising vessels to minimise use	No	Emissions during decommissioning activities is occurring in the context of the cessation of production. As such, almost all future emissions (from Project operations and vessels) will cease. Reviewing historical European Union (EU) Emissions Trading Scheme data and comparing with Comparative Assessment study suggests that emissions are likely to be small relative to those during production. A review of previous decommissioning Environmental Statements shows that atmospheric emissions are exclusively concluded to have no significant impact, and are usually extremely small in the context of UKCS/global emissions. Most submissions also note that emission from short term decommissioning activities are small in the context of the shutdown of operations.
ii) Power generation on Dunlin Alpha	Yes	No	No	No	No	P	- Contractor selection - maintenance programme, audits	No	As above.
2 Physical presence									
i) Physical presence of vessels in relation to other sea users	Yes	Yes	No	Yes	Yes	P	- Campaign, logistics, sharing vessels (across FEL portfolio) optimising vessels to minimise use - UKHO standard communication channels including Kingfisher, Notice to Mariners and radio navigation warnings - Collision risk assessment - Stakeholder consultation - Logistics plan - Fisheries Liaison officer	No	The presence of vessels for decommissioning activities will be relatively short term in the context of the life of the Dunlin Alpha platform. Activity will occur using similar vessels to those currently deployed for oil and gas across the Northern North Sea and the vessel days required for decommissioning will be comparable to operational vessel requirements. Vessels will also generally be in use around existing infrastructure and will not occupy 'new' areas. Other sea users will be notified in advance of activities occurring, meaning those stakeholders will have time to make any necessary alternative arrangements for the limited period of operations. A review of previous decommissioning Environmental Statements shows that some projects indicate a greater potential issue with short term vessel presence, but those largely relate to project-specific sensitive locations, which is not the case for this Project, especially as the nearshore activities are very likely to be limited in duration (limited to passing vessels).
ii) Physical presence of infrastructure decommissioned *in situ* in relation to other sea users	No	no	No	No	Yes	P	- Stakeholder consultation, especially discussion of issues with SFF - Notifications and notice to mariners - Provision of data to allow Admiralty chart updates - Retention of the 500 m safety zone (Note: this will exist until the point that the surface structures have collapsed below the water line, at which point FEL will make an application to renew the safety zone)	Yes	This option sees decommissioning of the CBGS and legs/steel transitions *in situ*. The OSPAR base case, and the preferred approach from a Regulatory perspective, is for full removal of the structure where possible (taking into account safety, environmental, technical feasibility, societal and economic factors). Additionally, decommissioning infrastructure *in situ* has been raised as a key stakeholder concern in this and many previous decommissioning projects. On this basis, further assessment is to be undertaken.

Aspect	Prepare for leave *in situ* of CGBS, legs and steel transitions	Deconstruct and remove topsides and transfer to shore	Install Navaids	Offshore debris clearance	Legacy	Planned/ Unplanned	Embedded mitigation	Further detailed assessment to be undertaken?	Support for position
3 Disturbance to the seabed									
i) Disturbance to the seabed	No	No	No	Yes	No	P	- Limit the footprint of the activities - Optimise rock placement (e.g. use of FFPV, bags, grade etc.) - Review of survey data for distribution of sensitivities - Use of DP rather than anchoring (if a barge is required, it will maintain station through tug control) - Stakeholder consultation	No	The seabed footprint will be extremely limited, and related largely to potential recovery of debris by ROV. Additionally, the Dunlin Subsea ES considered the impact on the seabed within the 500 m zone and beyond, concluding sensitivity was low and recoverability high, such that no significant impact was expected. On this basis, no further assessment is to be undertaken.
ii) Disturbance of the cuttings piles during decommissioning activities	No	No	No	No	No	P	- Minimise disturbance of cuttings piles.	No	Disturbance during decommissioning activities could, in theory, cause release of drill cuttings. However, there are no planned interactions with the drill cuttings, and thus no mechanism for impact. On this basis, no further assessment is undertaken. Note: Consideration of leaching hydrocarbons into the marine environment over time is considered in Item 4iv.
4 Discharges to sea									
i) Routine vessel (e.g. greywater, blackwater, ballast) and topsides facilities discharges	Yes	Yes	No	Yes	Yes	P	- IMO Ballast Water Management Convention, including Ballast water plan and log book - Treatment to IMO/MARPOL standards - Compliance with FEL's marine assurance standards - Hazmat checklist - Certification process for topsides preparation - No planned discharge to sea during facilities preparation	No	Discharges from vessels are typically well-controlled activities that are managed on an ongoing basis. Whilst these routine discharges are not generally considered to be a major oil and gas issue, a review of previous decommissioning Environmental Statements shows that these discharges are often included in assessment. However, submissions also note that potential impact of such limited emissions will be not significant.
ii) Chemical, hydrocarbon and other discharges (not from the legs, cells or drill cuttings)	No	no	No	No	No	P	- Selection of chemicals with less potential for environmental impact - Environmental risk assessment through the MATs/SATs system - Predefined cleanliness achieved through hydrocarbon freeing - Legs will be flooded with seawater such that hydrocarbon content will be ALARP	No	There are no planned releases, and thus no impact mechanism for further consideration.
iii) Gradual release of cell contents over time	No	no	No	No	Yes	P	- Previous Attic Oil Recovery Project - Waxy residues are strongly bonded to the walls so will not be released over time, until degradation of the structure. - Cell contents are compartmentalised, limiting the circulation of hydrocarbons or sediments that could be released from any single ingress to the structure	Yes	Such a release is likely to occur as a result of long term water ingress, rather than currents forcing contents out of the cells. However, release of water would see release of the aromatics and heavy metals within the water. Given this, along with the issue having been raised as a key area of concern for stakeholders and the novel nature of the impact mechanism, it will be necessary to provide additional definition of impact.
iv) Gradual release of hydrocarbons entrained in the drill cuttings over time	No	no	No	No	Yes	P		No	Assessment of the cuttings piles on both the cell tops and seabed indicates that neither OSPAR threshold for leaching (10 tonnes of oil leaching to the water per annum) and persistence (500 km2/y) are breached. In this instance, leaving the cuttings piles *in situ* without disturbance is considered to be an environmentally acceptable solution. On this basis, no further assessment of the fate of the drill cuttings when left undisturbed is to be undertaken. Note: Disturbance of cuttings piles is considered as part of line 10iii and 10iv.

Aspect	Prepare for leave *in situ* of CGBS, legs and steel transitions	Deconstruct and remove topsides and transfer to shore	Install Navaids	Offshore debris clearance	Legacy	Planned/ Unplanned	Embedded mitigation	Further detailed assessment to be undertaken?	Support for position
v) Release of leg contents during operations or over time once operations are complete.	No	No	No	No	Yes	P	Prior to removal, legs will be flooded with water. Cleaning operations will be undertaken to skim off residual contents. Further sampling will be undertaken to ensure FEL is satisfied that any remaining residual chemicals are at levels considered to be acceptable.	No	Given that the contents of the legs will be water with trace residual hydrocarbon content, release of such water over the long-term post-completion of decommissioning activities is not considered likely to cause significant impact.
5 Underwater noise									
i) Underwater noise from vessels (injury/disturbance to marine species)	No	Yes	No	Yes	Yes	P	- Campaign, logistics, sharing vessels (across FEL portfolio) optimising vessels to minimise use - Main potential impact likely to be from disturbance rather than injury - Contractor selection	No	The project will not be using any new activities that have not previously been assessed as 'acceptable' through previous permit applications in the area. This project is not located within an area protected for marine mammals. Cumulative use from multiple vessels is unlikely as more than one vessel will not be present for much of the activity. With appropriate industry standard mitigation measures, EIAs for offshore oil and gas decommissioning typically show no injury, or significant disturbance. For projects outside of protected marine mammal habitats, this issue can often be scoped out.
ii) Underwater noise from other sources, such as cutting of guide frames and conductors (injury/disturbance to marine species)	Yes	No	No	No	No	P	- Suitable technology for cutting will be selected to ensure the effectiveness of the cutting (conductors and guide frames likely to be cut using diamond wire or similar mechanical form of cutting, and not water jetting) - Minimising the duration, disturbance and risk of requiring the activity to be repeated	No	There will be very limited cutting activity below the water line, and this will be restricted largely to cutting of the guide frames and conductors. This project is not located within an area protected for marine mammals. Given the limited cutting activity, there will be very possibility for cumulative impact with vessel noise emissions.
6 Resource use (offshore and onshore)									
i) Use of raw materials and additives (including plastics, chemicals, steel)	Yes	Yes	Yes	Yes	Yes	P	- Planning of activities will minimise use of materials (there is also a financial driver for this) - Recycling as much as possible - Stakeholder consultation	No	Generally, resource use from the proposed activities will require limited raw materials (and be largely restricted to fuel use). Such use of resources is not typically an issue of concern in offshore oil and gas. Additionally, the BEIS and Decom North Sea guidance advises scoping out onshore related issues.
ii) Energy consumption (fuel use and power consumption by offshore and onshore plant/equipment)	Yes	Yes	Yes	Yes	Yes	P	- Monitor fuel use - Scheduling/design to optimise opportunities to use resources more efficiently (e.g. at same time)	No	Fuel use during decommissioning activities is occurring in the context of the cessation of production. As such, almost all future fuel use (from Project operations and vessels) will cease. Such use of resources is not typically an issue of concern in offshore oil and gas.
iii) Use of landfill space	No	Yes	No	Yes	Yes	P	- Maximise recycling opportunities - FEL Environmental Management System - Follow FEL waste management strategy and project management plan	No	Limited quantities of material will be returned to shore as a result of project activities, and most that is returned is expected to be recycled. There may be instances where infrastructure returned to shore is contaminated and cannot be recycled, but the weight/volume of such material is not expected to result in substantial landfill use. Additionally, the BEIS and Decom North Sea guidance advises scoping out onshore related issues.

Aspect	Prepare for leave *in situ* of CGBS, legs and steel transitions	Deconstruct and remove topsides and transfer to shore	Install Navaids	Offshore debris clearance	Legacy	Planned/ Unplanned	Embedded mitigation	Further detailed assessment to be undertaken?	Support for position
7 Onshore dismantling yard activities									
i) Airborne noise, including traffic movements at onshore sites	Yes	Yes	Yes	Yes	Yes	P	- Limit the duration of the noise emitting activities - Environmental audit of dismantling yard (including site visit) - Contractor management / selection - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Contract award could include recognition of social issues including noise	No	All onshore yards at which decommissioned material will be handled already deal with potential environmental issues as part of their existing site management plans. There is anticipated to be no change in potential for impact as a result of any of the material proposed for recovery. Whilst the yard(s) is yet to be selected, they will be in the UK or Europe. FEL procedures require suitably approved facilities, including site visits, review of permits and consideration of how new facility and construction and design has been developed to minimise impact. Additionally, the BEIS and Decom North Sea guidance advises scoping out onshore related issues.
ii) Emissions, such as release of chemicals, odour (e.g. from cutting, marine growth)	Yes	Yes	Yes	Yes	Yes	P	- Environmental audit of dismantling yard - Selection of a yard that has procedures in place to dispose of marine growth in a manner that will avoid odour nuisance - Marine growth management plan or waste management plan	No	As above.
iii) Light - onshore (including shadowing effects of any large structures)	Yes	Yes	Yes	Yes	Yes	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Stakeholder engagement	No	As above.
iv) Dust	Yes	Yes	Yes	Yes	Yes	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues - Bid evaluation for onshore activities should consider economic, environment and social issues - Environmental management plan	No	As above.
v) Visual aesthetics (onshore only)	Yes	Yes	Yes	Yes	Yes	P	- Environmental audit of dismantling yard - Yard to engage with local communities - Review records of engagement with communities and close out of issues	No	As above.
8 Waste generation									
i) Non-hazardous waste	Yes	Yes	Yes	Yes	Yes	P	- FEL waste management strategy, including targets for recycling - Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP prioritising reuse and recycling - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard/contractor waste management systems	Yes	It is waste management, not generation, that is the issue across DPs, with capacity to handle waste within the UK often cited as a stakeholder concern. Environmental documentation prepared to support DPs usually recognises this. As waste management is understood to be a key stakeholder interest in decommissioning, FEL expects to detail measures in place to manage waste in the EA. This will be outlined briefly in a section describing the Waste Management Plan and how the overarching strategy and guiding principles will be applied to manage the decommissioning programme. This section will not seek to replicate inventory data from the DP, or to quantify waste streams in detail, but instead discuss FEL expectations with regards appropriate handling.

Aspect	Prepare for leave *in situ* of CGBS, legs and steel transitions	Deconstruct and remove topsides and transfer to shore	Install Navaids	Offshore debris clearance	Legacy	Planned/ Unplanned	Embedded mitigation	Further detailed assessment to be undertaken?	Support for position
ii) Hazardous waste	Yes	Yes	No	Yes	Yes	P	- FEL waste management strategy - Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP prioritising reuse and recycling - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard/contractor waste management systems - Paint samples taken from legs and determined to be non-hazardous	Yes	As above.
iii) Radioactive waste (including naturally occurring radioactive material, low-specific activity material)	Yes	Yes	No	No	No	P	- FEL waste management strategy - Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP prioritising reuse and recycling - Contractor to maintain a waste audit trail through to recycling or disposal facility - Contractor to report waste inventories - Audit of yard/contractor waste management systems - Licensed facility capable of taking contaminated material under appropriate licence and disposing appropriately (e.g. incineration) - FEL procedures during preparation to return radioactive material to shore	Yes	As above.
iv) Marine growth	Yes	No	No	Yes	No	P	- Project waste management plan, use of licensed waste contractors/sites, waste transfer notes - Develop WMP - Contractor to maintain a waste audit trail through to recycling or disposal facility - Audit of yard's waste management - Consider jetting offshore - Marine growth management plan - As much marine growth as reasonably practicable will be removed offshore (much will be removed through scraping as conductors retrieved through the topsides)	Yes	As above.
9 Others									
i) Light - offshore	Yes	Yes	Yes	Yes	Yes	P	- Lighting directed below the horizontal plane unless required for technical or safety reasons - End of operational lighting, other than Navaids for safety	No	There will be a reduction in long-term light emissions from the activities, and activities will see no more light emissions than during normal operations. Activities will occur in summer when days are longer and less artificial light is required. There will be one navaid, which will emit light.
ii) Aesthetics - offshore/nearshore	No	Yes	No	No	No	P	- Campaign planning to limit vessel days to minimum required - Project location located well offshore - Other large installations brought nearshore known to attract visitors	No	Highly limited movement of vessels through the nearshore, and distant location of the offshore activities. There could be transfer from vessel to vessel during transfer to shore, but this would happen approximately 6 miles offshore and would be highly limited temporally.

Aspect	Prepare for leave *in situ* of CGBS, legs and steel transitions	Deconstruct and remove topsides and transfer to shore	Install Navaids	Offshore debris clearance	Legacy	Planned/ Unplanned	Embedded mitigation	Further detailed assessment to be undertaken?	Support for position
iii) Livelihood / employment	Yes	Yes	Yes	Yes	Yes	P		No	Whilst it is recognised that there could be a negative effect resulting from cessation of production, there will be a countering benefit in the additional work required to affect the decommissioning activities. It is expected that the key socio-economic effect would occur through potential interaction with fisheries (assessed as part of separate line items).
10 Unplanned events									
i) Accidental chemical/hydrocarbon release to sea from vessels (boats), including with platform	Yes	Yes	No	Yes	Yes	UP	- SOPEP, including modelling and appropriate response planning - Collision risk assessment - Maintenance procedures - SIMOPs - Bulk handling procedures and personnel training - Vessels will be selected which comply with IMO/MCA codes for prevention of oil pollution - Preferred operational procedures to be in place onboard vessels including use of drip trays under valves, use of pumps to decant lubricating oils, use of lockable valves on storage tanks and drums - Chemical storage areas contained to prevent accidental release of chemicals - Maintenance procedures - Pre-mobilisation audits will be carried out including a comprehensive review of spill prevention procedures - Arrangements in place to track spills - Adverse weather working procedures	No	The heavy lift vessel (HLV) will have the largest fuel inventory of the vessels involved in the decommissioning activities. However, the fuel inventory of such vessels is typically split between a number of separate fuel tanks, significantly reducing the likelihood of an instantaneous release of a full inventory of the vessel. Assuming a maximum inventory of approximately 18,000 m^3, split by approximately 10 tanks, a release of less than 2,000 m^3 is a credible scenario. Modelling undertaken for the Subsea Infrastructure EIAs indicated a release of approximately 3,500 m^3 would be unlikely to reach shore under most conditions, and with a probability of less than 5% even when modelling did indicate beaching. Interaction with protected sites would be limited to possibility in only six of 12 months, and with a maximum of 1% of inventory release. With such limited probability of a release, limited probability of beaching and interaction with protected sites, no further assessment is proposed.
ii) Accidental chemical/hydrocarbon release from topsides	Yes	Yes	No	No	No	UP	- Topsides isolation from sources prior to preparation - Flanging of release points - Venting of vessels to clear contents	No	Given the engineering down and cleaning that will be conducted, only very small volumes could remain within the topsides, and only some sources would demonstrate the potential for release. Given the probability of the release is remote, no further assessment is to be undertaken.
ii) Release of cell contents through collapse of concrete structure, objects falling during structure collapse, or collision from a third party	Yes	Yes	No	Yes	Yes	UP	- Previous Attic Oil Recovery Project - Cell contents are compartmentalised, limiting the volume that could be released from any single ingress to the structure - Geometry of the cells makes it difficult for falling debris to pierce the cells - Concrete legs are predicted to crumble rather than collapse	Yes	The worst-case scenario for consideration is the steel transition penetrating the cells and leading to a release of hydrocarbon. However, the Atkins study on the energy in any fall suggests it would not be sufficient to breach the cells. Despite the low probability, this issue has been raised as a key area of concern for stakeholders. Given the novel nature of the impact mechanism, it will be necessary to provide additional definition of impact. Note: Should the transition piece fall onto the CGBS as part of degradation of the Dunlin Alpha structure, it will weigh approximately half of its current weight, and may not be sufficiently heavy to break through into the cells. Furthermore, the presence of the drill cuttings on the Cell Tops provides a buffer for falling objects.
iii) Disturbance of drill cuttings through collapse of concrete structure, or objects falling during structure collapse	No	No	No	No	Yes	UP		Yes	Although the cuttings pile does not exceed OSPAR thresholds to leave *in situ*, it is possible that disturbance of the cuttings piles as the concrete structure begins to degrade could occur. Given that disturbance of cuttings piles has been raised as a key area of concern for stakeholders, further assessment of the possible impact will be undertaken.

Aspect	Prepare for leave *in situ* of CGBS, legs and steel transitions	Deconstruct and remove topsides and transfer to shore	Install Navaids	Offshore debris clearance	Legacy	Planned/ Unplanned	Embedded mitigation	Further detailed assessment to be undertaken?	Support for position
iv) Fishing interaction with drill cuttings pile	No	No	No	No	Yes	UP	- Stakeholder consultation - Notice to mariners - Kingfisher notifications - Drill cuttings within 500 m safety zone - Cuttings information to be provided for inclusion in FishSAFE system	No	This has been raised as a key area of concern for stakeholders. However, the cuttings are located within the 500 m safety zone that will remain after decommissioning and should not be preferentially targeted. Note: The scenario whereby a fishing vessel loses power with the gear deployed and which subsequently drifts into the cuttings pile is considered very remote and is excluded from further consideration.
v) Snagging of fishing gear	No	No	No	No	Yes	UP	- Stakeholder consultation - Notice to mariners - Maintenance of the 500m safety zone - Kingfisher notifications - Platform location and condition information at the end of decommissioning activities to be provided for inclusion in FishSAFE system	No	This is assessed as part of item 2ii.
vi) Dropped objects, including collapse of structure onto the seabed (not on the cells or drill cuttings)	Yes	Yes	Yes	Yes	Yes	UP	- FEL Environmental Management System - Procedures will be in place to reduce the potential for dropped objects - Training and awareness of contractors will be required - Lift planning will be undertaken to manage risks during lifting activities, including the consideration of prevailing environmental conditions and the use of specialist equipment where appropriate - All lifting equipment will be tested and certified - Procedures will be put in place to make sure that the location of any lost material is recorded and that significant objects are recovered where practicable	No	There exists the possibility that topsides could be transported by a vessel using a crane. Where these would be suspended over the side of the vessel for the transfer, the possibility of dropping onto a live pipeline cannot be ruled out. However, dropped object procedures are industry standard and there is only a very remote probability of any interaction with any live infrastructure. Note: There is potential for dropped objects as materials are being transported onshore. However, onshore issues are out of the scope of the EA.

Appendix B – Modelling Details

B.1 Overview

As outlined in Section 5, modelling has been undertaken to support both release of cell contents and disturbance of drill cuttings resulting from objects falling from above. This appendix provides further technical detail on the modelling undertaken; output of the modelling is embedded within Section 5 and is not repeated here.

B.2 Modelling Software

B.2.1 Cell Contents Release

The Scandinavian Independent Research Organisation (SINTEF) has developed a Marine Environmental Modelling Workbench (MEMW) interface to provide an interface for undertaking a range of modelling exercises. This interface provides an industry-standard mechanism for predicting the environmental fate of a user-defined release scenario. For the cell contents release, modelling was run in deterministic mode with a release of the mobile oil contained within the cells occurring over one hour. In doing this it was possible to understand the fate of the oil and to fully evaluate impacts on shoreline, sediment, water column and the sea surface over the duration of the release. It should be noted that deterministic modelling differs from stochastic modelling (commonly used for oil spill contingency planning) in two important aspects; firstly, in a deterministic model the sediment compartment is considered, and secondly oil may be removed from the beach after beaching.

B.2.2 Drill Cuttings Disturbance

The cuttings discharges were modelled using DREAM (Dose-related Risk and Effect Assessment Model), Sintef, part of the Marine Environmental Modelling Workbench (MEMW) suite of models, Version 9.0.0, which incorporates the ParTrack sub-model used for modelling the dispersion and settlement of solids. The model predicts the fate of materials discharged to the marine environment (their dispersion and physico-chemical composition over time) and it can also calculate an estimate of risk to the environment using a metric known as the Environmental Impact Factor (EIF).

The model has been developed to calculate the dispersion and deposition on the seabed of drilling mud and cuttings as well as the dispersion of chemicals in the free water masses. The calculations are based on the particle approach, combined with a near field plume model and the application of external current fields for the horizontal advection of the particles. The model consists of a plume mode and far-field mode. The plume mode takes into account affects from water stratification on the near field mixing, ambient currents and geometry of the discharge port. Once plume advection ceases, particles fall out of the plume and deposit on the bottom. Downwards (or rise) velocity of the particles is dependent on size and particle density and also on agglomeration of solids in the presence of oil-related components. The far-field model includes the downstream transport and spreading of particles and dissolved matter, once the plume mode is terminated. Further details of the model can be found at the Sintef Environmental Risk Management System Website (https://www.sintef.no/Projectweb/ERMS/Reports/).

B.3 Modelling Limitations

There are a number of limitations to consider when interpreting the outputs from any modelling exercise, in particular:

- Modelling results are to be used for guidance purposes only and response strategies should not be based solely on modelling results.
- The results are dependent on the quality of the environmental parameters and scenario inputs used.
- The resolution/quality of tidal and oceanic current data vary between regions and models.
- The properties of analogues in the model's database may not precisely match those of the discharge predicted.

If the same scenarios were to be modelled in another modelling programmes with identical parameters and inputs, the results may show a degree of variance. This is expected as the different fate and weathering models have been developed and programmed independently.

B.4 Modelling Inputs

B.4.1 Cell Contents Release

B4.1.1 Current Selection

The Oil and Gas UK shelf hourly current file which covers the period April 2011 until June 2014 and are freely available to all members to support MEMW modelling on the UKCS was used in this modelling. In the first instance the metocean data for the release location was reviewed to identify which metocean conditions led to interaction with the shore. The conditions that predicted the largest mass of oil on shore was then run as a standalone deterministic model (i.e. a release scenario under a defined set of environmental conditions) to allow the behaviour of the oil and dissolved components to be assessed in detail.

B4.1.2 Volume of the Discharge

Two over-arching scenarios were modelled to reflect gradual and instantaneous release of cell contents:

- Gradual release – as described further in Section 5, a single sub-compartment could fail. Up to 0.6 m^3 of mobile oil may be released occur over an extended period of time. To account for this in the modelling, this volume has been released over a period of 24 hours.
- Instantaneous release – three modelled scenarios of 50 m^3, 100 m^3 and 200 m^3 were undertaken. The 200 m^3 value released is considered to be worst-case as it has the effect of releasing the most mobile oil at a single point in time. In all instances, the metocean conditions most likely to result in a release arriving at shore were selected. Effectively, these scenarios model a near-instantaneous release of contents in weather conditions that drive the released contents to shore. Modelling input for the 100 m^3 and 200 m^3 scenarios are described below.

B4.1.3 Composition of the Discharge

The contaminant concentrations within the cells are presented in Xodus (2018) and summarised in Section 4. These contaminants are used as direct input to the model to describe the composition of the discharge.

B4.1.4 Rate of Discharge

Aspect	Gradual Release Input	Instantaneous Release Input (100 m^3 / 200 m^3)
Number of cells	N/A	4
Release volume (m^3)		
Mobile oil	*0.58*	*100 / 200*
Water phase	*0.06*	*13,000*
Exposure volume (m^3)		
Sediment	0.12	N/A
Wall residue	0.005	N/A
Release duration (hour)		
Mobile oil	24	0.5
Water phase	24	168
Sediment	24	N/A
Wall residue	24	N/A
Release rate (m^3/hour)		
Mobile oil	0.024	200 / 400
Water phase	0.003	77
Sediment	0.005	N/A
Wall residue	0.0002	N/A

B.4.2 Drill Cuttings Disturbance

B4.2.1 Current Selection

The Oil and Gas UK shelf hourly current file which covers the period April 2011 until June 2014 and are freely available to all members to support MEMW modelling on the UKCS was used in this modelling. These current files were analysed to determine the least dispersive period for the discharge location (i.e. at the Dunlin Alpha location near the seabed) and this was used for the subsequent modelling.

B4.2.2 Volume of Cuttings

The cuttings pile volumes have been derived from the Fugro (2018) drill cuttings report. Based on the scenarios described above, the following volumes were utilised in the model:

- 1% discharge – 255 tonnes;
- 5% discharge – 1,275 tonnes; and
- 10% discharge – 2,550 tonnes.

B4.2.3 Composition of the Discharge

The contaminant concentrations within the cuttings pile are presented in Fugro (2018) and summarised in Section 4. These contaminants are used as direct input to the model to describe the composition of the discharge.

B4.2.4 Nature of the Discharge

To approximate the instantaneous disturbance that would occur from a dropped object, the model assumes a single release location and a rapid discharge from a single location above the point of assumed impact. The material is released in accordance with the following assumptions:

- Discharge time: 1 hour; and
- Height above seabed: 30 m.