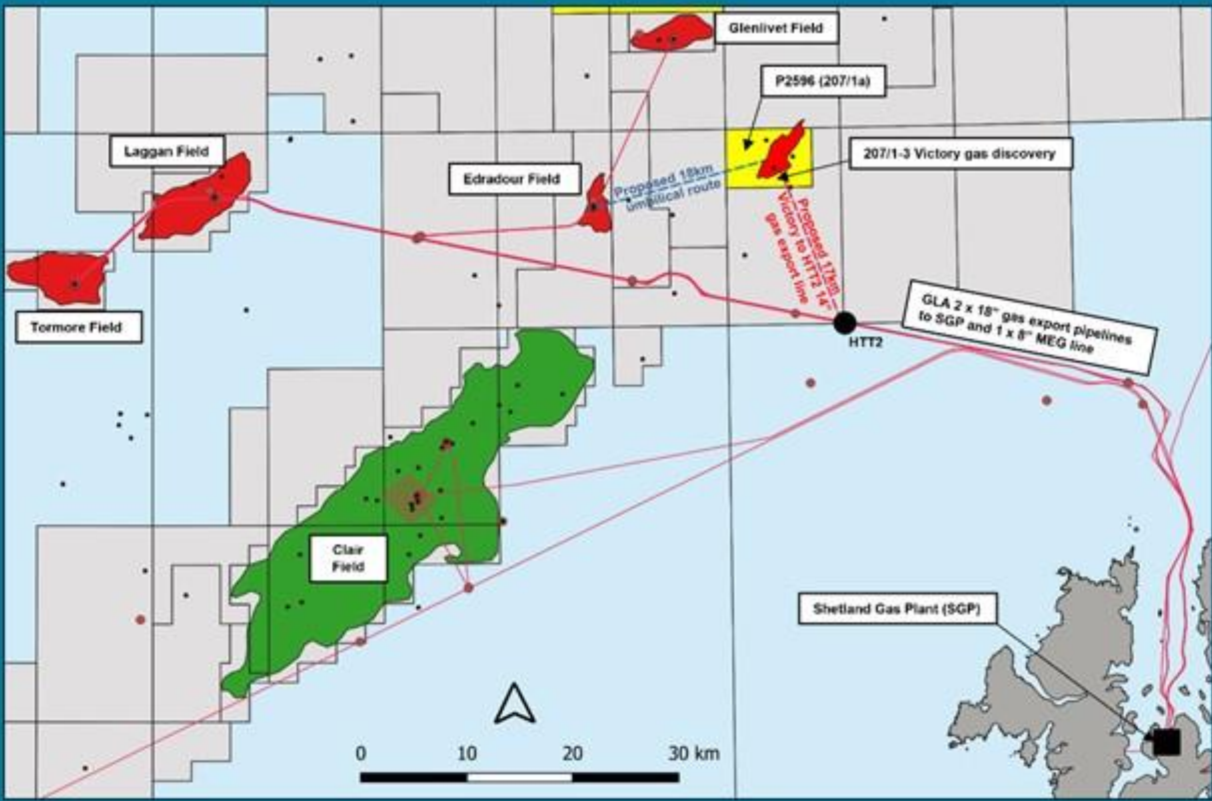
Corallian Energy Limited

Victory Field Development Environmental Statement



BEIS Ref: ES/2022/003

July 2022

Corallian Energy

ENVIRONMENTAL STATEMENT DETAILS

Section A: Administrative Information

A1 – Project Reference Number

Number: ES/2022/003

A2 – Developer Contact Details

Company Name: Corallian Energy Limited

Contact Name: [redacted]

Contact Title: Managing Director

A3 – ES Contact Details (if different from above)

As above.

A4 – ES Preparation

Please confirm the key expert staff involved in the preparation of the ES:

Name	Company	Title	Relevant Qualifications / Experience
[redacted]	Orbis Energy Limited	Director	[redacted] has over 20 years environmental consultancy experience in the oil and gas industry. She has a first class B.Sc (Hons) degree in Environmental Science.
[redacted]	Orbis Energy Limited	Director	[redacted] has over 18 years environmental consultancy experience in the oil and gas industry. He has a M.Sc (by research) in Environmental Science (Environmental Toxicology) and a B.Sc (Hons) in Marine & Freshwater Biology.
[redacted]	Orbis Energy Limited	Principal Consultant	[redacted] has 15 years of experience in HSE management in the upstream oil and gas sectors. He has a Bachelor of Science (Hons) in Environmental Health and is a Graduate Member of IEMA.
[redacted]	Orbis Energy Limited	Senior Consultant	[redacted] has 9 years environmental consultancy experience in the oil and gas industry. He has a first class master's degree in Environmental Science (MEnvSci).
[redacted]	Orbis Energy Limited	Consultant	[redacted] has 2 years environmental consultancy experience in the oil and gas industry. She has a Bachelor of Science (Hons) in Marine Biology and a Master of Science in Conservation.

A5 – Licence Details

a) Please confirm licence(s) covering proposed activity or activities

Licence number(s): P2596

b) Please confirm licences and current equity

Licence Number: P2596	
Licensee	**Percentage Equity**
Corallian Energy Limited	100%

Section B: Project Information

B1 – Nature of Project

a) Please specify the name of the project.

Name: Victory Field Development

b) Please specify the name of the ES (if different from the project name).

As above.

c) Please provide a brief description of the project:

Corallian Energy Limited (Corallian) is the operator of Seaward Production Licence P2596, which contains the Victory gas field, located in United Kingdom Continental Shelf (UKCS) Block 207/01a, approximately 47 km north west of the Shetland Islands. Corallian has 100% equity in the licence.

The Victory field will be developed via a single subsea well tied-back via a new 16.2km, 14 inch pipeline to one of the hot tap tees installed in TotalEnergies' existing Greater Laggan Area (GLA) network infrastructure. Control of the well will be from TotalEnergies' Edradour manifold, located approximately 18 km to the west-south-west, via a new umbilical.

The field will be operated from the GLA control room at the Shetland Gas Plant (SGP) located onshore on the north coast of the main island of Shetland. When the production fluids arrive onshore, the liquids (condensates) will be removed and piped to the nearby Sullom Voe oil terminal, while the gas will be processed before being transported to the UK grid via the Shetland Island Regional Gas Export System (SIRGE) and Frigg UK Association (FUKA) pipelines.

Subject to the necessary consents and approvals, Corallian intends to conduct detailed engineering surveys and a rig site survey in the summer of 2023 to allow development drilling and subsea installation activities to be undertaken between May and October of 2024. First gas is targeted for Q4 2024.

Victory peak production day rates are anticipated to be 4.209 million cubic metres (148.640 million standard cubic feet) per day of gas and 15.36 tonnes (23.63 cubic metres) of condensate per day by around Year 3 (P10 case).

The Victory subsea infrastructure will have a design life of 15 years and the economic field life is expected to be between 7 and 10 years depending on the reserves, the production rate and the life of the GLA infrastructure. On cessation of production, the Victory facilities will be decommissioned in accordance with the requirements of the prevailing UK and International law.

B2 – Project Location

a) Please indicate the offshore location(s) of the main project elements.

Aspect	Victory Well	Hot Tap Tee (Tie-in Location)	Edradour Manifold
Location (Lat/Long) [1]	60° 58' 10.163" N 01° 54' 31.955" W	60° 50' 3.328"N 01° 48' 2.245"W [2]	60° 56' 4.403" N 02° 13' 54.256" W
UKCS Block	207/01a	207/01	206/04a
Distance to nearest coastline (Shetland)	47 km	32 km	56 km
Distance to nearest median line (UK / Faroe)	110 km	121 km	95 km

[1] ED50 UTM Zone 30N.

[2] This is the provisional design location of the hot tap tee.

B3 – Previous Applications

If the project, or an element of the project, was the subject of a previous consent application supported by an ES, please provide details of the original project.

N/A

Table of Contents

Abbreviations

%	Per cent
°C	Degrees Centigrade
°F	Degrees Fahrenheit
µg	Micrograms
µm	Micrometre
ACA	Action Co-ordinating Authority
AFEN	Atlantic Frontier Environmental Network
ALARP	As Low As Reasonably Practicable
API	American Petroleum Institute
BACs	Background assessment concentrations
bbl	barrels
bcf	Billion cubic feet
BCFG	billion cubic feet of natural gas
BOP	Blowout Preventer
BP	British Petroleum
BSL	Benthic Solutions Limited
CCS	Carbon Capture and Storage
CEFAS	Centre for Environment, Fisheries and Aquaculture Science
CH_4	Methane
CHARM	Chemical Hazard Assessment and Risk Management
CO	Carbon Monoxide
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CO_2e/boe	Carbon Dioxide equivalent per Barrel of Oil Equivalent
Corallian	Corallian Energy Limited
CPI	Carbon Preference Index
Cu	Copper
dB	Decibel
dB re 1 µPa	Decibels relative to one micro-Pascal
DECC	The Department of Energy and Climate Change
DP	Dynamic Positioning
DST	Drill Stem Test
DSV	Dive Support Vessel

EC	European Commission
ED50	European Datum 1950
EDR	Effective Deterrent Range
EEMS	Environmental Emissions Monitoring System
EI	Emission Intensity
EIA	Environmental Impact Assessment
EPS	European Protected Species
ERL	Effects Range Low
ERM	Effect range median
ERRV	Emergency Rescue and Recovery Vessel
ES	Environmental Statement
ESAS	European Seabirds at Sea
ESC	European Slope Current
ETS	Emissions Trading Scheme
EU	European Union
EUNIS	European Nature Information System
FDP	Field Development Plan
FeAST	Feature Activity Sensitivity Tool
FEED	Front End Engineering Design
FLO	Fisheries Liaison Officer
FUKA	Frigg UK Association (pipeline)
GHG	Greenhouse Gas
GLA	Greater Laggan Area
GRP	Glass Fibre Reinforced Polymer
GWC	Gas Water Contact
GWP	Global Warming Potential
GWP_{100}	100-year Global Warming Potential
H_2S	Hydrogen Sulphide
HC	Hydrocarbon
HF	High Frequency
HM	Heavy and trace metals
HPHT	High Pressure, High Temperature
HSE	Health and safety Executive
HSE MS	Health, Safety and Environmental Management System
HSE MS	Health, Safety and Environmental Management System

HTT2	Hot Tap Tee 2
Hz	Hertz
ICES	International Council for the Exploration of the Seas
IMCA	International Marine Contractors Association
IMO	International Maritime Organization
IoP	Institute of Petroleum
IPCC	Intergovernmental Panel on Climate Change
IRCD	Injection Rate Control Device
ISO	International Standards Organization
ITOPF	International Tanker Owners Pollution Federation
IUCN	International Union for the Conservation of Nature
JNCC	Joint Nature Conservation Committee
KCl	Potassium chloride
kHz	Kilohertz
km	Kilometre
LF	Low Frequency
LoD	Limit of Detection
m	Metre
m^3	Cubic Metre
MAH	Major Accident Hazard
MAT	Master Application Template
MBES	Multi-beam Echo Sounder
MEG	Mono-ethylene Glycol
MEI	Major Environmental Incident
MER	Maximising Economic Recovery UK Strategy
mm	millimetres
mmboe	Million barrels of oil equivalent
MMMU	Marine Mammal Management Unit
MMO	Marine Mammal Observer
MMscf	Million cubic feet
MMscf/d	Million cubic feet per day
MoD	Ministry of Defence
MODU	Mobile Offshore Drilling Unit
MPA	Marine Protected Area
MPS	Marine Policy Statement

MSS	Marine Scotland Science
MSV	Multi-Service Vessel
Mt	Million Tonnes
MU	Management Unit
N_2O	Nitrous Oxide
NC MPA	Nature Conservation Marine Protected Area
ng	Nanogram
nm	Nautical mile
NMP	National Marine Plan
NO_2	Nitrogen Dioxide
NOAA	National Oceanographic and Atmospheric Administration
NORBRIT	Norway-UK Joint Contingency Plan
NO_x	Nitrogen Oxides
NSTA	North Sea Transition Authority
OESEA	Offshore Energy Strategic Environmental Assessment
OEUK	Offshore Energy UK
OGA	Oil and Gas Authority (now NSTA)
OGUK	Oil & Gas United Kingdom (now OEUK)
OMAR	Offshore Major Accident Regulator
OPEP	Oil Pollution Emergency Plan
OPOL	Offshore Pollution Liability Association
OPPC	Oil Pollution Prevention and Control
OPRED	Offshore Petroleum Regulator for Environment and Decommissioning
OSPAR	Oslo and Paris Commission
OVID	Offshore Vessel Inspection Database
PAH	Polycyclic Aromatic Hydrocarbons
Pb	Lead
PCW	Phocid carnivores in water
PE	Parabolic equation
PETS	Portal Environmental Tracking System
PEXA	Practice and Exercise Area
PLEM	Pipeline End Manifold
PLONOR	Pose Little or No Risk
PMF	Priority Marine Feature
PSA	Particle size analysis

PSD	Particle size distribution
PTS	Permanent Threshold Shift
ROV	Remotely Operated Vehicle
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SAT	Subsidiary Application Template
SCANS	Small Cetacean Abundance in the North Sea
SCM	Subsea Control Module
SCR 2015	The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015
SD	Standard Deviation
SEA	Strategic Environmental Assessment
SEC	Shelf Edge Current
SEL	Sound Exposure Level
SFF	Scottish Fishermen's Federation
SG	Specific Gravity
SGP	Shetland Gas Plant
SIRGE	Shetland Island Regional Gas Export System
SNCB	Statutory Nature Conservation Body
SNH	Scottish Natural Heritage (now known as NatureScot)
SO_2	Sulphur Dioxide
SOPEP	Ship Oil Pollution Emergency Plan
SOSI	Seabird Oil Sensitivity Index
SPA	Special Protection Area
SPL	Sound Pressure Level
SSS	Side Scan Sonar
SSSI	Sites of Special Scientific Interest
THC	Total Hydrocarbon Concentration
TOC	Total Organic Carbon
TOM	Total Organic Matter
TOOPEP	Temporary Operations Oil Pollution Emergency Plan
TS	Threshold shift
TTS	Temporary Threshold Shift
UET	Umbilical End Termination
UK	United Kingdom

UKCS	United Kingdom Continental Shelf
UTM	Universal Transverse Mercator
VHF	Very High Frequency
VMS	Vessel Monitoring System
VOC	Volatile Organic Compounds
WBM	Water-Based Mud
WHPS	Wellhead Protection Structure
WOAD	Worldwide Offshore Accident Database
WoSPS	West of Shetland Pipeline System

Non-Technical Summary

Introduction

Corallian Energy Limited (Corallian) is the operator of Seaward Production Licence P2596, which contains the Victory gas field, located in United Kingdom Continental Shelf (UKCS) Block 207/1a, approximately 47 km north west of the Shetland Islands (Figure 1). The nearest international boundary is the UK/Faroe median line, which lies approximately 110 km to the north west of the Victory development location. Corallian has 100% equity in the licence.

The Victory field is located within a water depth of approximately 160 m and was discovered in 1977, when the 207/01- 3 well encountered a thick, high quality sandstone reservoir containing lean, dry gas. Corallian is now proposing to develop the Victory field as a subsea tie-back and is progressing with engineering studies with the aim to deliver first gas by Q4 2024.

An Environmental Statement (ES) has been prepared to present the findings of the Environmental Impact Assessment (EIA) carried out for the proposed Victory field development, as required under The Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020. The ES has been prepared by Corallian in conjunction with Orbis Energy Limited (the EIA Consultant). This section forms the non-technical summary of the ES.

Project Description

The Victory field will be developed via a single subsea well tied-back via a new 16.2km, 14 inch pipeline to one of the hot tap tees installed in TotalEnergies' existing Greater Laggan Area (GLA) network infrastructure. Control of the well will be from TotalEnergies' Edradour manifold, located approximately 18 km to the west-south-west, via a new umbilical. The field will be operated from the GLA control room at the Shetland Gas Plant (SGP) located onshore on the north coast of the main island of Shetland. When the production fluids arrive onshore, the liquids (condensates) will be removed and piped to the nearby Sullom Voe oil terminal, while the gas will be processed before being piped across the UK.

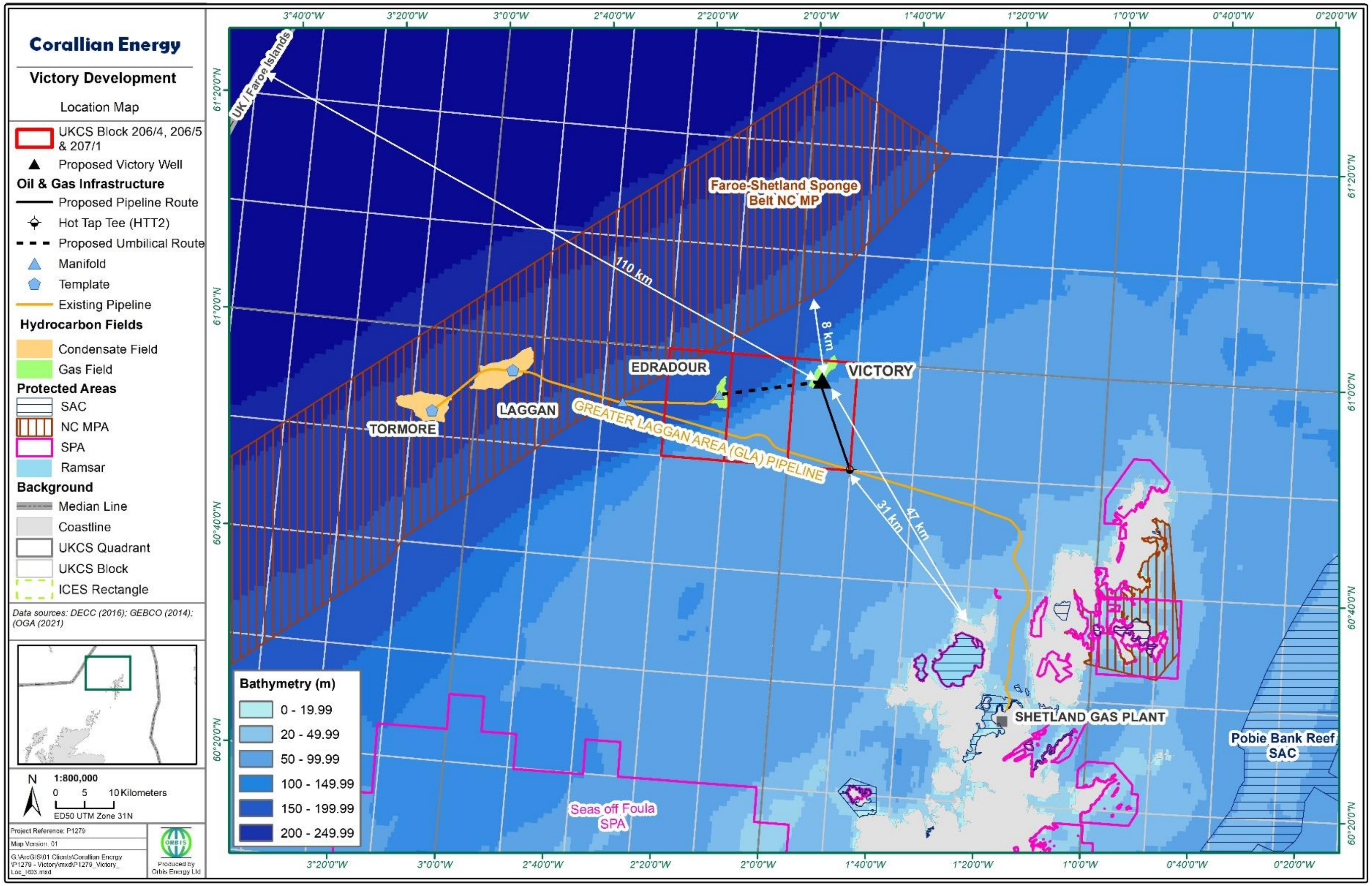
It is proposed that the Victory development well (termed the '207/1a-F well') will be drilled using a moored semi-submersible drilling rig. Drilling activities will be undertaken concurrently with the subsea installation activities, scheduled to occur between May and October in 2024. Well design work is still being progressed; however, for the purposes of the EIA a well with a 90 m long inclined section through the reservoir has been assumed, the total length of the well is expected to be around 1,277 m. It is anticipated that the well will take approximately 52 days to complete.

Two options are being considered for installation of the Victory pipeline and umbilical, including installing rock protection both underneath and on top of the pipeline and umbilical (worst case) or creating very narrow pre-cleared corridors, from which any residual boulders greater than 0.5 m will be removed, before laying the pipeline and umbilical within these corridors and covering them with rock (base case). The worst case scenario has been assessed within the EIA. Protective stabilisation material will be required in the form of mattress protection and rock dumping to ensure the integrity of the infrastructure in certain places. The vessels used during the installation process will be dynamically positioned (DP). A Dive Support Vessel (DSV) and/or multi-service vessel (MSV) will be required to install the Wellhead Protection Structure (WHPS), Pipeline End Manifold (PLEM) / Pigging Skid, Tie-in Structure and Hot Tap Tee 2 (HTT2) Protection Structure and to support tie-in and pre-commissioning activities. It is currently anticipated that the pipeline and umbilical installation and the installation of the subsea structures, as well as hook-up and commissioning activities will occur between May and October of 2024.

As Victory will be a subsea development, production from the field will be processed onshore at the SGP with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the Victory development. Atmospheric emissions during the Victory production phase will therefore mainly arise from power generation requirements at SGP. There will be no emissions and discharges to the marine environment during routine production operations at the Victory field.

The Victory subsea infrastructure will have a design life of 15 years and the economic field life is expected to be between 7 and 10 years depending on the reserves, the production rate and the life of the GLA infrastructure. On cessation of production, the Victory facilities will be decommissioned in accordance with the requirements of the prevailing UK and International law. The design of the Victory facilities also allows for the Victory field to be re-purposed for carbon capture and storage at a later date, after cessation of production.

Figure 1. Location of the Proposed Victory Field Development



Concept Selection

Initial technical studies confirmed that the optimum development option for Victory in terms of economics, risk and environmental impact is via a single well subsea tie-back to existing infrastructures. An initial screening exercise concluded that gas from Victory could potentially be exported via two pre-existing infrastructure systems; either the TotalEnergies' operated GLA pipelines or the BP operated West of Shetland Pipeline System (WoSPS); or alternatively via a new, dedicated system for Victory alone.

The viability and environmental impact of the following four options has been assessed in the EIA:

- Option 1: Subsea tie-back via a c.17 km 14 inch pipeline to the GLA pipeline HTT2 (with control from the Edradour subsea manifold via a 18 km umbilical);
- Option 2: Subsea tie-back via a 41 km 14 inch pipeline to the Clair Ridge Platform and onwards via a 14 km 12 inch pipeline to the WoSPS (with control also from the Clair Ridge Platform via a 41 km umbilical);
- Option 3: Subsea tie-back via an 80 km 14 inch pipeline to the SGP (with control from the Edradour subsea manifold via a 18 km umbilical);
- Option 4: Subsea tie-back via an 80 km 14 inch pipeline to the SGP (with control from the SGP via an 80 km umbilical).

A further four options involving a common pipeline and umbilical route from Victory back to the Edradour or Glenlivet subsea manifolds (options 5 and 6) and the possibility of expanding the control system from Glenlivet instead of Edradour for the pipeline tie-back routes to the HTT2 and the SGP (options 7 and 8) were also initially considered during the concept selection phase but were discounted early on, primarily due to technical issues.

The assessment concluded that the concept of a tie-back to the GLA system via HTT2 (Option 1) is superior to that of a tie-back to the WoSPS (Option 2) or the SGP (Options 3 and 4). Option 1 is preferred as it is the simplest and best defined of the options, carries the lowest risk, can be executed at the lowest cost and with the greatest economic return and has the lowest environmental impact. In addition, this tie-back option is considered to be the most efficient export route for Victory gas and may also prolong the life of the GLA system and the SGP by adding significant additional resources to this existing infrastructure.

For option 2, BP has advised that tie-back to the Clair Ridge platform is not a viable option as the asset does not have the capacity to handle Victory's flow rates or supply MEG to the Victory wellhead.

For options 1, 3 and 4 there is little difference in the environmental impact, including the greenhouse gas emissions produced, during the production phase as processing of the Victory fluids for all these options will occur onshore at the SGP.

The decommissioning strategy for all options routed through the GLA infrastructure (options 1, 3 and 4) is similar and would allow for the Victory field to be re-purposed for carbon capture and storage at a later date, after cessation of production. For option 2, Clair Ridge has a much longer field life than Victory, therefore potentially preventing the repurposing of the Victory infrastructure.

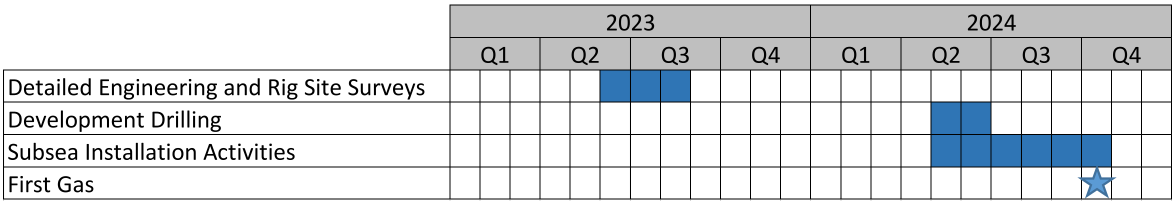
Victory in the Context of Net Zero

Production from Victory represents lower than average emissions per tonne of oil equivalent produced compared with other gas fields on the UKCS or imported sources. All gas produced from the Victory field will flow to the SGP and will be used domestically and not exported. Development of the Victory gas field provides the UK with a comparatively low carbon indigenous gas source during the transition to renewable energy, helping contribute to energy security and assist in the delivery of Net Zero UK carbon emissions by 2050. The design of the Victory facilities also allows for the Victory field to be re-purposed for carbon capture and storage at a later date, after cessation of production.

Project Schedule

The preliminary schedule for the proposed Victory field development is provided in Figure 2.

Figure 2. Preliminary Schedule for the Victory Development



The Existing Environment

The EIA process requires a comprehensive review of the existing environment in order to provide a basis for assessing the potential interactions between a project and the receiving environment. A high-level summary of the environmental sensitivities within the vicinity of the proposed Victory field development area is provided below.

The description of the baseline environment is largely based on data provided in the OPRED Offshore Energy Strategic Environmental Assessment (SEA) Reports (2003-2016), as well as other published data sources. In addition, site-specific data collected by Benthic Solutions Limited (BSL) on behalf of Corallian in June 2021 has been incorporated, where relevant. Data were collected over the main Victory site, the proposed pipeline route to the Hot-Tap-Tee No. 2 (HTT2) tieback and two proposed umbilical routes to the Edradour and Glenlivet subsea manifolds.

The oil and gas infrastructure in the wider area has also been subject to a number of site-specific surveys over the years. Several of these surveys are in close proximity to the proposed Victory field development area and have therefore been used to inform the environmental baseline description, where relevant, including historic surveys at Edradour, Glenlivet and along the Yell Sound pipeline route to the Laggan field.

Physical Environment

The proposed Victory development is located close to the edge of the West of Shetland continental shelf, approximately 47 kilometres (km) north west of the Shetland Islands (refer to Figure 1 above). The water depth at the proposed Victory well location was recorded as 169.3 m and ranged from 195.8 m in the NW corner of the main Victory site survey area to 148.4 m in the SE corner. Along the HTT2 route water depths decreased towards Shetland, reaching a minimum depth of 133 m. Along the Edradour route water depths sloped gently away from the Victory site reaching a depth of 303.9 m (BSL, 2021a).

The seabed across the main Victory site is characterised by sand ripples and megaripples. Smaller megaripples were focussed in the north (approximately 8 to 10 m in length) with larger meggaripples (approximately 15 to < 50 m) observed in the south (BSL, 2021a).

The West of Shetland area, is characterised by persistent, long-period swells, complex current regimes and rapidly changing weather conditions. The deep water over the edge of the continental slope West of Shetland is exposed to a large fetch and strong winds, particularly from the west and southwest. Tidal current speed and direction measured at the nearest Admiralty tidal diamond to the proposed Victory development (Tidal Diamond H, Admiralty Chart 245) indicate that the maximum tidal rates in the region of the proposed development are 0.26 and 0.1 ms-1 respectively for spring and neap tides (Hydrographer of the Navy, 2011).

Although offshore winds around the proposed Victory development may blow from any direction, they principally blow from west to south-west, with winds of force 5 (8m/s) or greater reported 70% of the time in winter and 30% of the time in the summer (DECC, 2016). The average sea surface temperature across the Victory area in West of Shetland waters ranges from 9-10°C, and the average near-bed temperature ranges from 8-9°C (Marine Scotland, 2021a).

Biodiversity

The collective term plankton describes the plants (phytoplankton) and animals (zooplankton) that live freely in the water column and drift passively with the water currents. Plankton form the base of the food chain, therefore changes in the abundance and composition of the planktonic community can have impacts on higher consumers. Zooplankton is a primary food source for fish, seabirds and whales. The zooplankton community in the Victory area includes the larval stages of fish (ichthyoplankton), larval decapods (crustaceans) and echinoderms, as well as copepods and krill (also crustaceans).

Benthos describes the organisms that live within and on the seabed. Benthic organisms can be classified further into infauna, organisms that live within the sediment, and epifauna, organisms that live on top of the seabed (attached or mobile). In general, the seabed faunal community in the vicinity of the Victory Development is expected to be relatively abundant and diverse; characteristic of sandy sediments. Species including starfish, brittle stars, holothurians, hermit crabs, bryozoan, teleost fish, tubeworms, anemones and encrusting sponges have previously been observed in the area.

A number of fish species are likely to be present within the Victory Development area. Species that may spawn within the vicinity include herring, haddock, lemon sole (*Microstomus kitt*) Norway pout (*Trisopterus esmarkii*), saithe, sandeels (*Ammodytes spp*.) and whiting (*Merlangius merlangus*). The area surrounding the Victory development may also act as a nursery grounds for anglerfish, blue whiting (*Micromesistius poutassou*), cod, common skate (*Dipturus batis-complex*), European hake, haddock, herring, horse mackerel (*Trachurus trachurus*), lemon sole, ling, mackerel, Norway pout, saithe, sand eel, spotted ray (*Raja montagui*), spurdog (*Squalus acanthias*) and whiting. Species of sharks, skates and rays may also be present in the vicinity of the Victory Development, these include basking sharks, blue shark, common skate, cuckoo ray, lesser-spotted dogfish, porbeagle shark, portugese dogfish, sandy ray, spurdog and starry ray.

A number of seabirds are present in the vicinity of the Victory Development area throughout the year; the area is considered important for great skua and northern fulmar in the breeding season. Species which are likely to be present in the area during the breeding bird season, in addition to great skua and northern fulmar, include kittiwake (*Rissa tridactyla*), great black-backed gull (*Larus marinus*), herring gull (*Larus argentatus*), Atlantic puffin (*Fratercula arctica*), gannet (*Morus bassanus*), razor bill (*Alca torda*), common guillemot (*Uria aalge*) and European storm petrel (*Hydrobates pelagicus*). Seabird sensitivity to oil pollution within the Victory Development area is considered to be generally low between May and September, low to medium between November and February, high to very high in October and low to high in March.

Species of marine mammals likely to be present in the waters West of Shetland and the vicinity of the proposed Victory development include harbour porpoise, minke whale, Risso's dolphin and white-beaked dolphin. Additionally, killer whale, pilot whale and white-sided dolphin have been observed in the waters surrounding the proposed development. Seals are widely distributed along the east coast of Scotland; however, studies of grey and harbour seals have indicated that their density within the proposed Victory Development area is low.

The nearest MPA to the proposed Victory development area is the Faroe-Shetland Sponge Belt Nature Conservation Marine Protected Areas (NC MPA), which lies approximately 8 km to the north west of the Edradour manifold location at its closest point. This NC MPA is designated for the protection of nine features of conservation interest: deep sea sponge aggregations, ocean quahog (*Arctica islandica*) aggregations, Atlantic and Arctic influenced offshore subtidal sand and gravel habitats, an area of the Faroe-Shetland Channel continental slope and five geodiversity (geomorphological) features representative of the West Shetland Margin paleo-depositional system and the West Shetland Margin Contourite Deposits key geodiversity areas. No ocean quahog individuals were recorded in the macrofauna data at Victory, no potential relict shells were observed along video transects and no live individuals or their distinctive siphons were noted during analysis of video footage and still photographs from the survey area.

Human Environment

Fishing effort in the vicinity of the Victory Development tends to be highest between April to May and between October and November. The area is utilised by both the UK and international fishing fleets. Fishing activity in the Victory Development area is dominated by trawls. In the vicinity of the proposed Victory development the demersal fishing effort was found to be high. The pelagic (mackerel and herring) fishing effort was found to be low to medium in the vicinity of the proposed Victory development; occurring at higher intensity towards the south and east, closer to shore.

Commercial shipping activity within the vicinity of the Victory Development is considered to be very low, with the majority of vessels consisting of container ships, ferries and cruise liners.

The proposed Victory well will tie back into the existing Greater Laggan Area (GLA) pipeline located approximately 17 km south east of Victory. The GLA pipeline is part of TotalEnergies 'West of Shetland' (WOS) operations, which includes the producing Laggan, Tormore, Edradour and Glenlivet fields and the Glendronach field located south of the Edradour field, which is in the development stage. The closest surface oil and gas infrastructure to the proposed Victory development is the Clair Ridge platform located approximately 41 km south west of the proposed Victory well, followed by the Clair platform located approximately 45 km south west of the proposed Victory well. Both of these platforms are operated by BP.

There are no planned, consented or operational offshore wind farms within the vicinity of the proposed Victory development area. In addition, there are no military Practice and Exercise Areas.

Identification and Assessment of Potentially Significant Impacts

The EIA process undertaken for the Victory field development has aimed to identify and assess all potentially significant environmental effects arising from the proposed project (both from planned activities and unplanned (accidental) events). Cumulative and transboundary impacts have also been considered.

For planned activities, the significance of environmental effects has been evaluated by considering the sensitivity of the receptor affected in combination with the magnitude of impact that is likely to arise. For unplanned events, such as accidental hydrocarbon releases, significance has been determined using a risk assessment approach, where the likelihood (probability) of the unplanned event occurring is considered against the consequence (significance of effect) if the event was to occur.

An initial scoping exercise identified a number of aspects (activities or events) which could potentially result in significant environmental effects. A comprehensive assessment was therefore undertaken for these aspects and, where necessary, measures identified to prevent or reduce what might otherwise be significant adverse environmental effects through design evolution or operational mitigation measures. These aspects were then reassessed assuming the successful implementation of the identified mitigation measures to determine residual effects.

A summary of the main findings of the EIA process is provided below.

Physical Presence

The physical presence of the Victory development, both above and below the sea surface, has the potential to interfere with the activities of other users of the sea (specifically shipping and fishing). The temporary presence of the mobile offshore drilling unit (MODU) and other working vessels, at the surface can pose a navigation hazard to shipping and fishing vessels, and may lead to an accidental event such as a collision. The risk of a collision will be minimised by implementing measures, including marking of the 500 m exclusion zone on appropriate navigation charts, using guard vessels to ensure other sea users are aware of the operations and following standard maritime communication and notification measures. Below the sea surface the physical presence of the mooring system of the MODU and the long term presence of the seabed development infrastructure will pose a potential snagging hazard to fishing gears in the area. Additionally, during the installation of the pipeline and umbilical, fishing vessels will be temporarily displaced from the working corridors, with the area remaining unavailable to commercial fisheries until rock has been placed over the lines for protection and upheaval buckling mitigation. Fishing activity will also be excluded from the 500 m exclusion zone in place around the wellhead during the life of the Victory field. The total area that will be lost (0.8 km^2), however, represents a very small proportion of the entire fishing area available in the West of Shetland. All seabed infrastructure and the rock berms over the length of the pipeline and umbilical will be designed to be overtrawlable. In conclusion, no significant adverse residual effects to other sea users (shipping and fishing) are predicted as a result of the physical presence of the Victory development.

Seabed Disturbance

The maximum total area of seabed that will be directly impacted by the Victory development is estimated at around 1.29 km^2. The seabed will be disturbed through the anchoring of the MODU, the discharge of drill cuttings, muds and cement and the installation of the Victory subsea infrastructure and associated protection material. Impacts to the seabed have the potential to interfere and cause adverse effects to seabed sediments, seabed communities (i.e. benthic flora and fauna) and fish.

MODU anchoring will cause localised direct abrasion damage to the seabed covering an area of ca. 0.07 km^2 and will also result in sediment re-suspension, and subsequent smothering of habitats and species. Sessile epifauna, and a proportion of the infauna (animals that burrow into the sediment or form tubes within it) in the direct footprint area of the MODU anchoring pattern will be lost from compression and abrasion. However, recovery and re-colonisation of the impacted area is expected to occur as soon as the MODU departs with no long term changes to the benthic community predicted. Given the sediment type (sand with negligible silt content) and moderate energy environment, any seabed scarring is not expected to persist beyond the short to medium term.

As a worst case, it has been assumed that the WBM cuttings discharged from the Victory well (512 tonnes) will be deposited within an area of ca. 0.85 km^2, with the thickest part of the pile within ca. 50 m of the well. Any drill cuttings which may be contaminated with residues of reservoir hydrocarbons and cement would also be deposited within this area. The effects on seabed fauna from the deposition of WBM cuttings and fine solids are usually subtle or undetectable, although the presence of drilling material at the seabed close to the drilling location (less than 500 m) is often detectable chemically. However, near seabed current velocities and sediment mobility in the West of Shetland area appear generally sufficient to prevent detectable local accumulation of cuttings from persisting in the short to medium term.

The subsea infrastructure installation activities will result in the loss of some sandy sediment habitat, and also the introduction of novel hard substrata. This will mostly comprise of rock protection berms over the pipeline and umbilical and mattresses together with smaller areas of coated steel from which infrastructure items are fabricated. The total area of long-term sandy sediment habitat loss is estimated to amount to approximately 0.37 km^2; this is small in comparison to the area of similar habitat available across the wider area. The area beneath the subsea infrastructure and protection material will become unavailable for re-colonisation by soft sandy sediment inhabiting infauna and over time a new rocky substrate habitat will become established. Ultimately, this new seabed feature is expected to be colonised by the same types of mobile and encrusting epifaunal animals already present on cobbles and boulders in the wider area. The introduction of novel hard substrata by the Victory field development is very small and, whilst it will represent a change to the benthic environment locally it is not expected to cause any widespread changes to the marine life present in the area.

An Annex I habitat stony reef assessment (after Irving, 2009) conducted over the Victory development area found one area of 'low' reef at the southern end of the proposed HTT2 pipeline route. Corallian therefore commit to acquire further environmental data along the proposed pipeline route, as required, during the detailed engineering surveys scheduled to be undertaken in 2023, to reconfirm the 2021 survey results and aid micro siting of the pipeline, thereby avoiding any significant impacts to this habitat type.

Ocean quahog is on the OSPAR list of threatened and/or declining species and, although not recorded during the Victory environmental survey, is known to be present in the wider area. The ocean quahog is highly sensitive to physical pressures and changes in seabed habitat types (i.e. the introduction of new hard substrata). Any impacts will, however, be in a very localised area, such that any effects on the population of ocean quahog in the wider West of Shetland region are not predicted to be significant.

No deep-sea sponge aggregations and no colonies (living or dead) of *L. pertusa* were observed during the Victory environmental survey, which is consistent with the findings of other surveys undertaken in the nearby area.

In conclusion, no significant adverse residual effects to seabed sediments, seabed communities and fish are predicted from seabed disturbance associated with the Victory development operations.

Underwater Noise Emissions

Underwater noise generated during the proposed Victory development has the potential to disturb, or cause injury to, a number of species in the marine environment, particularly fish and marine mammals. Significant levels of underwater noise may be generated and transmitted considerable distances in the marine environment during piling activities when the Victory subsea infrastructure is being installed, when there is a requirement for vessels to use Dynamic Positioning thrusters and during the proposed drilling operations. However, all of these activities will be temporary in nature. Corallian will implement a range of measures to mitigate any potential impacts including optimising duration of drilling and installation activities to minimise vessel usage, timing piling activities to avoid periods of high sensitivity for marine mammals and fish, and adhering to the Joint Nature Conservation Committee (JNCC) guidelines for minimising injury and disturbance to marine mammals. In conclusion, no significant adverse residual effects to fish and marine mammals are predicted from noise associated with the Victory development operations.

Atmospheric Emissions

Combustion of hydrocarbons for power generation on the MODU, vessels, and helicopters during the development of the Victory field, as well as flaring of hydrocarbons during the well flow test, will result in atmospheric emissions. During the production phase, gas from the Victory field will be processed at the SGP with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the development; however, as the SGP is located onshore, the emissions arising at the SGP as result of the Victory development are outside of the scope of this EIA.

At a local level, impacts to air quality arising from the atmospheric emissions generated during the proposed Victory development operations are predicted to be Negligible. Emissions will disperse rapidly from source given the open and dynamic metocean environment in the West of Shetland region.

Due to the residence time of GHG emissions in the atmosphere, it is recognised that development of the Victory field will contribute to climate change impacts in combination with the other projects and activities emitting GHG emissions. Corallian is therefore committed to minimising the amount of GHG emission produced, with the chosen field development concept option producing the lowest levels of GHG emissions relative to the alternative concepts. During drilling and installation operations, vessel days and fuel consumption will be reduced, as far as practicable. The well test and well clean-up activities will be designed not only to achieve their goals but to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely.

The GHG emissions associated with the Victory development represent only a small proportion of GHG emissions typically arising from oil and gas developments in the UKCS and will only contribute a small fraction of CO2e emissions towards future UK carbon budget targets. Production from Victory also represents significantly lower than average emissions per tonne of oil equivalent produced compared with other gas fields on the UKCS or imported sources. All gas produced from the Victory field will flow to the SGP and will be used domestically and not exported.

In summary, development of the Victory gas field provides the UK with a comparatively low carbon indigenous gas source during the transition to renewable energy, helping contribute to energy security and assist in the delivery of Net Zero UK carbon emissions by 2050. The design of the Victory facilities also allows for the Victory field to be re-purposed for carbon capture and storage at a later date, after cessation of production.

Marine Discharges

The main operational discharges into the marine environment from the proposed Victory development will occur as a result of the discharge of drill cuttings, muds and cement, residual hydrocarbons when drilling through the payzone, chemicals during drilling, installation and hook-up and commissioning activities and completion brine during well clean-up activities. Upon release, these discharges will be subject to rapid dilution and dispersion and are not expected to persist within the marine environment. Additionally, a number of studies have shown that any impacts will be limited to the local area in the immediate vicinity of the discharge location and therefore no significant adverse residual effects are predicted.

Corallian will implement a range of measures to mitigate any potential impacts including undertaking a chemical risk assessment to identify the risk profile of chemicals being used and / or discharged in accordance with the requirements of the Offshore Chemicals Regulations 2002 (as amended). Where practicable, chemicals with a higher risk profile will be substituted out in favour of those with an improved environmental profile. During the proposed drilling operations, any discharges of residual reservoir hydrocarbons will be treated to meet oil-in-water limits of less than or equal to 30 mg/l. The discharge stream will also be monitored and sampled in accordance with an approved Oil Discharge Permit.

Accidental Events

All offshore activities associated with the Victory Development will carry a potential risk of hydrocarbon pollution to sea; however, hydrocarbon spills from normal oil and gas operations are uncommon and can be effectively mitigated against.

In planning its activities, Corallian's primary focus is to ensure that all practicable measures are taken to prevent the occurrence of such accidental events and, should they occur, mitigate their effects. The consequences of an accidental release will vary depending on the quantity and type of hydrocarbon spilt, the wind speed and direction and sea state and the sensitivity of receptors depending on the time of year.

The worst-case spill scenario from the Victory Development would be an uncontrolled flow of condensate from the proposed 207/1a-F well (i.e. a well blowout). Oil spill modelling has been conducted to determine the fate of Victory hydrocarbons released from this worst case scenario. As the UK/Norwegian median line is located approximately 202 km to the east, there is a low potential for a surface slick of condensate to cross the median line (9% in autumn), similarly, there is a low potential to cross the UK/Faroe Islands median line (3% in winter). There is a moderate possibility shoreline oiling will occur on the Shetland Islands, located approximately 47 km south east of the Victory Development. The maximum probability of shoreline oiling on the Shetland Islands occurs during the autumn with a 28 % chance and the minimum time to shore occurs during the winter, with oil reaching the coastline within 50 hours. However, the Victory condensate is a light hydrocarbon and, as such, it would be rapidly broken up by wind and wave action and evaporate. The risk of an accidental release occurring from the Victory Development will be minimised through the implementation of physical barriers such as downhole safety valves, maintenance to minimise leaks, and the development and implementation of handling and operational procedures and training.

Measures to respond to a spill from the MODU or the Victory subsea facilities once operational will be covered in approved oil pollution emergency plans, which will be prepared in advance of drilling operations commencing offshore. As such, the overall risk to the marine environmental from an accidental release of hydrocarbons from the Victory development is considered to be Low and not significant.

Environmental Management

Corallian conducts all of its activities and operations in accordance with an Environmental Management System (EMS), which has been designed to meet the requirements of ISO 14001. This system provides the structured management framework within which environmental impacts are identified, assessed, controlled, and monitored.

The Corallian EMS is the mechanism that ensures the company standards are maintained, that the commitments specified in the ES are met and that unforeseen aspects of the proposed Victory field development are detected. This structured management approach will be used to ensure that the on-going process of identification, assessment and control of environmental risks will continue throughout planning and operations of the field development.

Conclusion

In summary, it is concluded that the proposed Victory field development will not result in any significant environmental effects provided that all identified mitigation measures are implemented.

1 Introduction

1.1 Background and Purpose

Corallian Energy Limited (Corallian) is seeking permission from the North Sea Transition Authority (NSTA) to develop the Victory gas field located within United Kingdom Continental Shelf (UKCS) Block 207/1a, Seaward Production Licence P2596, approximately 47 kilometres (km) north west of the Shetland Islands (see Figure 1.1). Corallian has 100% equity in the licence.

Victory is located within a water depth of approximately 160 metres (m) and was discovered by well 207/01- 3, drilled by Texaco in 1977, which encountered a thick, high quality sandstone reservoir containing lean, dry gas. Corallian is now proposing to develop the Victory field as a subsea tie-back and is progressing with Front End Engineering and Design (FEED) studies with the aim to deliver first gas by Q4 2024.

As part of the consenting process for the Victory field development, Corallian is required to submit a Field Development Plan (FDP) to the NSTA. To support the FDP, an Environmental Statement (ES) must also be submitted to the Offshore Petroleum Regulator for Environment and Decommissioning (OPRED) for consideration under the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 as the proposed development will produce more than 500,000 cubic metres of gas per day and more than 500 tonnes of condensate.

This document is the ES for the proposed Victory field development (the Project) and presents the findings of the Environmental Impact Assessment (EIA) undertaken to determine if the Project is likely to have any significant effects on the environment.

1.2 Project Overview

The Victory field will be developed via a single subsea well tied-back via a new 14 inch pipeline to one of the hot tap tees installed in TotalEnergies' existing Greater Laggan Area (GLA) network infrastructure. Control of the well will be from TotalEnergies' Edradour manifold, located approximately 18 km to the west-south-west, via a new umbilical.

The field will be operated from the GLA control room at the Shetland Gas Plant (SGP) located onshore on the north coast of the main island of Shetland. When the production fluids arrive onshore, the liquids (condensates) will be removed and piped to the nearby Sullom Voe oil terminal, while the gas will be processed before being piped across the UK.

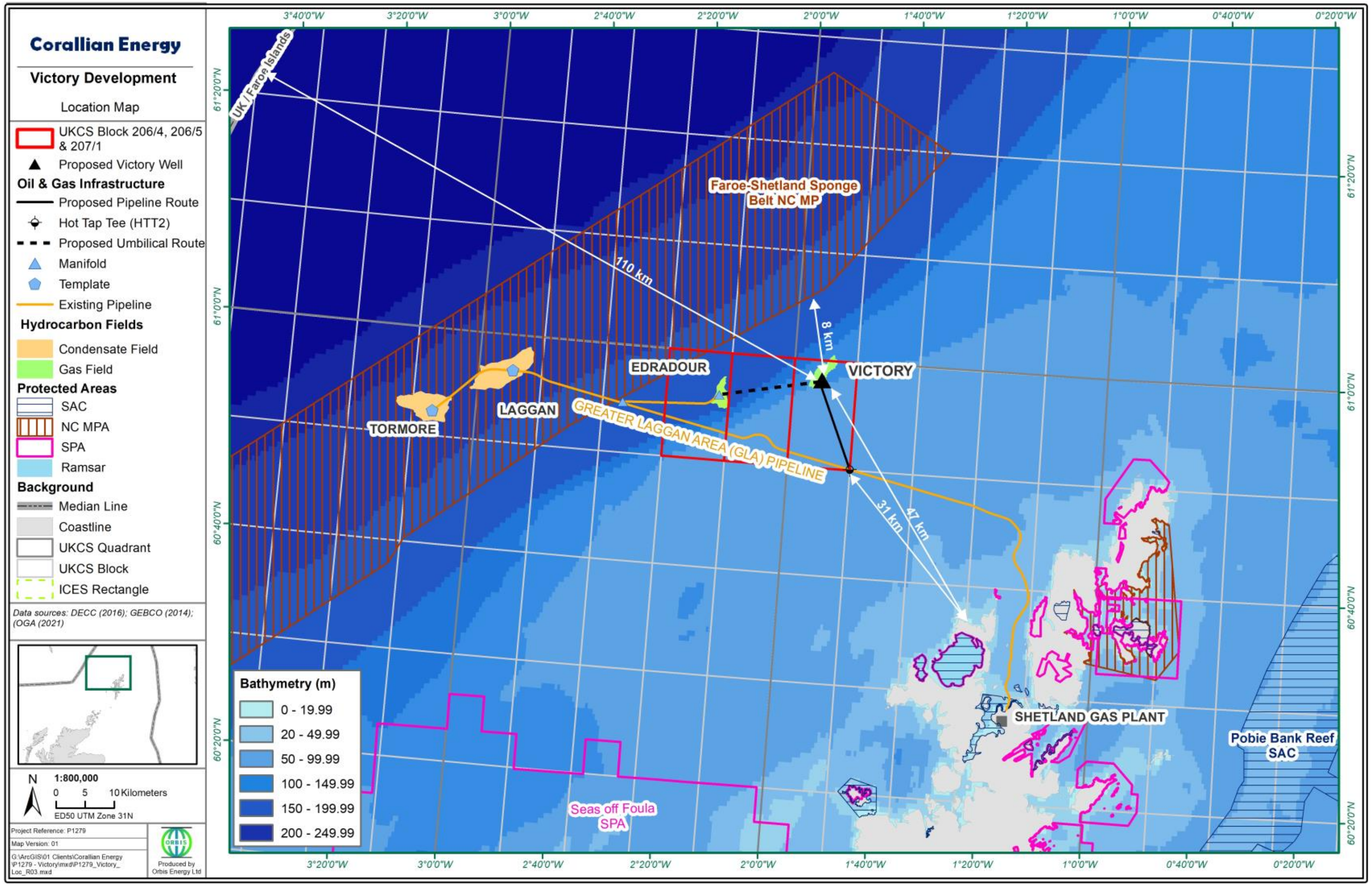
The location of the proposed Victory infrastructure is summarised in Table 1.1.

Table 1.1. Location of Proposed Victory Development Infrastructure

Aspect	Victory Well	Hot Tap Tee (Tie-in Location)	Edradour Manifold
Location (Lat/Long) [1]	60° 58' 10.163" N 01° 54' 31.955" W	60° 50' 3.328"N 01° 48' 2.245"W [2]	60° 56' 4.403" N 02° 13' 54.256" W
UKCS Block	207/01a	207/01	206/04a
ICES Rectangle	50E8	50E8	50E7
Distance to nearest coastline (Shetland)	47 km	32 km	56 km
Distance to nearest median line (UK / Faroe)	110 km	121 km	95 km

[1] ED50 UTM Zone 30N.
[2] This is the provisional design location of the hot tap tee.

Figure 1.1: Location of the Proposed Victory Field Development



Subject to the necessary consents and approvals, Corallian intends to conduct the detailed engineering surveys and rig site survey in the summer of 2023 to allow development drilling and subsea installation activities to be undertaken in the summer (May to October) of 2024. First gas is targeted for Q4 2024.

Victory peak production day rates are anticipated to be 4,209 million cubic metres (148,640 million standard cubic feet) per day of gas and 15.36 tonnes (23.63 cubic metres) of condensate per day by around Year 3 (P10 case).

The Victory subsea infrastructure will have a design life of 15 years and the economic field life is expected to be between 7 and 10 years depending on the reserves, the production rate and the life of the GLA infrastructure. On cessation of production, the Victory facilities will be decommissioned in accordance with the requirements of the prevailing UK and International law.

1.3 The Applicant

Corallian Energy Limited is a private UK oil and gas company. The Company holds interests in four basins in the UK: West of Shetland, Central Graben, Inner Moray Firth and Viking Graben, and has an experienced in-house team to execute its planned programme of work.

It is the policy of Corallian to manage its activities in a responsible manner that protects the health and safety of its employees, contractors and the public, and minimises adverse impacts on the environment. To help achieve this, the company operates under a combined health, safety and environmental management system (HSE MS), as described in Section 12.

As the offshore licensee for P2596, Corallian is responsible for the Victory field development during all lifecycle phases of the Project. However, under The Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015, Corallian plans to appoint third party well and pipeline operators to manage the Victory well and pipeline operations, subject to approval by the NSTA. Corallian will ensure that appointed well and pipeline operators meet all relevant environmental responsibilities through appropriate audit, monitoring and review arrangements and that the commitments made within this ES are implemented as the Project progresses.

1.4 Legislation and Policy Framework

1.4.1 Environmental Legislation

The Petroleum Act 1998 establishes the regulatory regime which is applicable to oil and gas exploration and production in the UK. It vests all rights to the nation's petroleum resources in the Crown, but permits the NSTA to grant licences that confer exclusive rights to 'search and bore for and get' petroleum.

The NSTA (formerly the Oil and Gas Authority) was set up in response to the recommendations of the Wood Review of 2014 and aims to regulate, influence and promote the UK oil and gas industry in order to maximise the economic recovery of the UK's oil and gas resources. The NSTA are also working with government and industry on the vital role that the oil and gas industry must play in the UK energy transition, in driving to net zero carbon across the UKCS as quickly as possible.

The Petroleum Act is supplemented by various environmental Acts and Regulations, which Corallian will need to ensure compliance with. OPRED is responsible for regulating environmental and decommissioning activity for offshore oil and gas operations on the UKCS and is part of the Department for Business, Energy & Industrial Strategy (BEIS).

As noted in Section 1.1, the EIA undertaken for the Victory field development as reported in this ES has been carried in accordance with the Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 (the 'EIA Regulations'). These regulations require that where a project falls within Schedule 1 of the Regulations there is a mandatory requirement for an EIA and the application for consent must be supported by an ES. The Victory field development qualifies as a Schedule 1 project as it will involve the extraction of natural gas for commercial purposes where the amount extracted exceeds 500,000 cubic metres per day.

Other environmental Acts and Regulations pertinent to the proposed Victory field development and therefore considered during the EIA process include, but are not limited to:

- The Climate Change Act 2008 (as amended);
- The Climate Change (Scotland) Act 2009 (as amended);
- The Energy Act 2008 (as amended);
- Marine and Coastal Access Act 2009 (as amended);
- The Marine (Scotland) Act 2010;
- The Merchant Shipping (Oil Pollution Preparedness, Response and Cooperation) Regulations 1998 (as amended);
- The Offshore Chemicals Regulations 2002 (as amended);
- The Offshore Installations (Emergency Pollution Control) Regulations 2002;
- The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015;
- The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended);
- The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended).

Further detail on these items of legislation, as well as other international treaties and agreements such as the Oslo and Paris (OSPAR) Convention, applicable to the Project is provided in Appendix A.

1.4.2 Marine Planning Policy

The Marine and Coastal Access Act 2009 and The Marine (Scotland) Act 2010 established a new legislative and management framework for the marine environment allowing the competing demands on the sea to be managed in a sustainable way across all of Scotland's seas.

The framework includes the following elements:

- UK Marine Policy Statement (MPS): the UK Administrations share a common vision of having clean, healthy, safe, productive and biologically diverse oceans and seas.
- Scottish National Marine Plan (NMP): sets out strategic policies for the sustainable development of Scotland's marine resources out to 200 nautical miles.
- Regional Marine Plans: marine planning will be implemented at a local level within Scottish Marine Regions, extending out to 12 nautical miles (nm). Applicable to the Victory field is The Shetland Islands Regional Marine Plan.

The Scottish NMP sets out specific key issues for the oil and gas sector in supporting the objectives of the plan, including:

- Maximise extraction;
- Re-use infrastructure;
- Transfer of skills to renewables and Carbon Capture and Storage (CCS);
- Co-operation with the fishing industry;
- Noise impacts to sensitive species;
- Chemical and oil contamination of water, sediments and fauna; and
- Habitat changes.

The proposed Victory field development, as described in this ES, has been assessed against all relevant NMP objectives and policies, as well as relevant policies in The Shetland Islands Regional Marine Plan, to confirm that the Project will not adversely impact them (see Appendix A for further details).

1.4.3 UK Government's Energy Policy

The Energy White Paper (HM Government, 2020) sets out how the UK will clean up its energy system and reach net zero emissions by 2050. In relation to the UK's domestic oil and gas industry, it identifies a number of key commitments, including:

- Working with the regulators, we will drive the reduction of greenhouse gas emissions from all offshore oil and gas operations to make the UK continental shelf a net zero basin by 2050.
- We will commit the UK to the World Bank's 'Zero Routine Flaring by 2030' initiative and will work with regulators towards eliminating this practice as soon as possible in advance of this date.
- We will undertake a review of OPRED to drive up environmental standards in its regulatory role, and support the sector's progress towards net zero emissions.
- We will take powers to ensure we maintain a secure and resilient supply of fossil fuels during the transition to net zero emissions.

It acknowledges that the UK's domestic oil and gas industry has a critical role to play in maintaining the country's energy security. Domestic production still met 46% of the country's supply of gas in 2019 and government forecasts show that oil and gas will remain an important part of the UK's energy mix for the foreseeable future, including under net zero.

The NSTA is fully committed to enabling the achievement of the UK government's commitment to reach net zero emissions by 2050. The revised OGA Strategy (OGA, 2020a), which amends the Maximising Economic Recovery Strategy (MER) UK Strategy, came into force on 11 February 2021 and places an obligation on the oil and gas industry to assist the Secretary of State in meeting the net zero carbon by 2050 target. Specifically, relevant persons must, in the exercise of their relevant activities, take the steps necessary to:

a. Secure that the maximum value of economically recoverable petroleum is recovered from the strata beneath relevant UK waters; and, in doing so,

b. Take appropriate steps to assist the Secretary of State in meeting the net zero target, including by reducing as far as reasonable in the circumstances greenhouse gas emissions from sources such as flaring and venting and power generation, and supporting carbon capture and storage projects.

Following this the North Sea Transition Deal (BEIS, 2021a), announced in March 2021, set out an ambitious plan for how the UK's offshore oil and gas sector and the government will work together to deliver the skills, innovation and new infrastructure required to meet stretching GHG emissions reduction targets, including development and implementation of the OGA's Net-Zero Asset Stewardship Expectation (OGA, 2021a).

Section 2.3 of this ES sets out how the proposed Victory field development concept is in line with the revised OGA Strategy, as well as other key energy transition and net zero strategy and policy documents.

1.5 Structure of the ES

The structure of this ES is summarised in Table 1.2 on the following page.

Table 1.2. ES Structure

Section Content	Content
Non-Technical Summary	A high level summary of the EIA to allow the non-specialist reader to understand the proposed Victory field development and its main environmental impacts and proposed mitigation measures.
Main Document	
Section 1: Introduction	Explains the background and purpose of the Victory field development, introduces Corallian and summaries the key issues raised during the stakeholder engagement process.
Section 2: Option Selection	Outlines the main concept options (alternatives) considered for the Victory field development and discusses the Project in the context of the UK's Net Zero commitment.
Section 3: Project Description	Describes the subsea infrastructure to be installed for the Victory development and provides an overview of each lifecycle phase of the field development, including drilling operations, installation of the subsea infrastructure, hook-up and commissioning, production operations and decommissioning.
Section 4: Existing Environmental Baseline	Describes the current environment at the Victory location, with particular emphasis on those aspects which are likely to be affected by the proposed development operations.
Section 5: Assessment Methodology	Presents the impact assessment methodology used for the EIA and identifies those aspects of the environment that are likely to be significantly affected by the Project.
Sections 6 – 11: Assessment Sections	These sections assess if the Project is likely to have any significant effects on the environment, define the proposed mitigation measures which will be implemented and determine the residual impacts (i.e. they document the assessment results). Where relevant, transboundary, in-combination and cumulative impacts are also assessed.
Section 12: Environmental Management	Describes Corallian's EHS MS and the management processes that will be applied throughout the Project to ensure adverse impacts on the environment are minimised.
Section 13: Conclusions	Reports the conclusions of the EIA process.
Section 14: References	Provides a bibliography of data sources referenced in the ES.
Appendices	
Appendix A: Legislation and Marine Policy	Provides an overview of the key environmental legislation and marine policy pertinent to the Project.
Appendix B: Oil Spill Modelling Study	Details the results of the oil spill modelling study undertaken for the Project.
Appendix C: Cuttings Modelling	Provided the results of the cuttings modelling which was undertaken for the Project.

1.6 Stakeholder Engagement

An informal meeting was held with OPRED, the Joint Nature Conservation Committee (JNCC) and Marine Scotland Science (MSS) on the 2nd December 2021 to introduce the Project, present the results of the Victory habitat assessment and environmental baseline survey, as well as other known key environmental sensitivities in the area, and provide an update on the EIA. Corallian also met with the Scottish Fishermen's Federation (SFF) on the 13th January 2022. A further meeting was held with OPRED on 2nd March 2022. The outcome of these meetings was used to inform the scope of the EIA and content of this ES.

The key issues raised during the stakeholder engagement process and, where applicable, how these issues have been addressed within the ES, are detailed in Table 1.3.

Table 1.3. Summary of Key Issues Raised during the Stakeholder Engagement Process

Organisation	Issues Raised	Addressed in ES
OPRED	In relation to Net Zero, OPRED confirmed that the ES should set out how the proposed Victory development will help deliver on the pathway to achieving net zero. In addition, OPRED confirmed that emissions arising at the SGP as result of the Victory development do not need to be included in the ES. Where relevant, information on SGP has been provided for background information only.	Section 2.3 and Section 3.5.2
	Recommended preliminary concept figures of the protection structures are included.	Section 3.4
	Requested that bathymetry and soil profile along the pipeline and umbilical route are included. Note, as the pipeline engineering surveys have not yet been undertaken only surface sediment data is available. However, a worst case pipeline installation methodology has been assessed and the findings from other operator's surveys nearby to the Victory field have been used to supplement the baseline data collected by Corallian to evidence that the location, installation method and design of the pipelines are relevant and have taken account of known environmental sensitivities in the area. Corallian also commit to acquire further environmental data along the chosen pipeline and umbilical routes, as required, during the detailed engineering surveys scheduled to be undertaken in 2023.	Section 2.2.3, Section 3.3.4, Section 4 and Section 7
	Asked if Block 207/01 was subject to a licence condition requiring a herring spawning seabed survey to be undertaken prior to drilling. Note, Corallian has subsequently checked and no such condition is attached to the block (OGA, 2019). It was requested that within the ES Corallian assess the potential for herring spawning given the sediment type, particle size and environmental conditions for the proposed development.	Section 4.3.3
	Acknowledged that Corallian had conducted oil spill modelling for a worst case blowout scenario and noted that the ES would also need to assess the potential for a major environmental incident (MEI) to occur.	Section 11
JNCC	Recommended that the field development location map show the proposed Victory infrastructure in relation to nearby marine protected areas.	Figure 1.1 in Section 1.1
	Noted that the ES should include quantities and location of rock dump and concrete mattresses required for the subsea infrastructure. It should also review the feasibility of removing this material during decommissioning.	Sections 3.4 and 3.6
	Recommended that the low reefiness feature observed along the proposed pipeline route to HTT2 should be avoided, if possible. The ES should include diagrams to clearly show where along the route the feature was found.	Section 4.3.2 and Section 7

Organisation	Issues Raised	Addressed in ES
MSS	Corallian explained that a common route back to Edradour for the proposed Victory pipeline and umbilical was not feasible. As this would result in the least impact to the seabed, it was recommended that this option was discussed in the Option Selection section of the ES to explain why it had been discounted. It was also recommended that a comparison table of the various development options would be beneficial and consideration should be given to the decommissioning strategy for the various options. The ES should also consider the various pipeline installation and drilling methods considered to confirm how the base case was selected and reference should be made to how other pipelines in the area have been laid in support of the chosen option.	Section 2.2
	When looking at the Project in the context of Net Zero, it was recommended that the ES should confirm if the infrastructure was being designed to be suitable for use in the future as a CCS facility.	Section 2.3
	Recommended that the ES consider the potential for free span formation of the pipelines, particularly in areas where the sediments are more mobile and the megarippled sand areas identified. Identifying any current free spans on pipelines in the area is also advised. MSSs also advised that the cumulative impacts section should take account of other pipelines in the area that have also been rock dumped. The preferred option for MSS would be a trenched and buried pipeline and umbilical where possible with justification provided for any deviation from this.	Section 3.4.4
	In relation to fish spawning areas over the Victory area, it was noted that there is an additional research paper on cod spawning (González-Irusta and Wright, 2016) which should be referenced in addition to the Coull *et al.* 1998 and Ellis *et al.* 2012 data. It was also recommended that the particle size analysis (PSA) results from the Victory baseline survey are reviewed to look at the potential for fish spawning in the area.	Section 4.3.3
	It was noted that the Victory area contains an important demersal fishery. MSS recommended contacting SFF to ensure any impacts on commercial fisheries are minimised, including legacy impacts if any infrastructure is to be left in-situ.	See issues raised by SFF below
	It was recommended that the ES should assess compliance with the objectives and policies in the Shetland Islands Regional Plan (relevant to impacts in the inshore environment), as well as those in the Scottish National Marine Plan.	Section 1.4.2 and Appendix A
	Corallian confirmed that no live ocean quahog individuals or potential relict shells were noted during analysis of the Victory seabed video footage and still photographs and no individuals were recorded in the macrofauna data. However, MSS noted that even though the Victory survey did not find any evidence of ocean quahog, there are mapped instances of the species occurring in the area (see data on the NMPi). It was also recommended that the Feature Activity Sensitivity Tool (FeAST) tool is used to assess impacts on species.	Section 4.3.2 and Section 7.3
	Noted that if looking at comparison studies to determine the impact to the seabed from mud and cuttings discharges, the composition of muds, quantities discharged and metocean parameters would need to be appropriate for comparisons to be drawn.	Section 7.3

Organisation	Issues Raised	Addressed in ES
SFF	Confirmed that the area was heavily fished, by both Scottish and international vessels, with activity recorded in almost every week of the year. It was noted that when the GLA pipelines were installed a stretch around two thirds of the way offshore was found to be a "hot spot" area for fishing vessels and required the use of three guard vessels per 10 km section.	Section 4.4.1 and Section 6
	Noted that the ES should consider the cumulative impact Victory may have on fisheries in the area along with other proposed projects, including Rosebank.	Section 6.6
	Corallian noted that concrete mattresses would be placed over tie-in spool pieces for protection. SFF stated that if the mattresses were being laid outside of 500m zones they would need to be rock dumped.	Section 3.4.5
	Recommended that the ES should assess the gear type used in the area in terms of effort in days, as well as the commercial aspect of the catch composition, which on its own can be misleading, i.e. the catch from pelagic vessels may be commercially more lucrative but pelagic vessels are likely to fish for fewer days than those using demersal gears.	Section 4.4.1

2 Project Alternatives

2.1 Introduction

Corallian has explored various concepts to develop the Victory field. This section describes the main alternatives considered, the associated environmental implications of each option and the reasons why the selected concept has been chosen. It references the Victory concept selection study (Corallian, 2021) undertaken to determine the optimum development plan for the field in terms of economics, technical risk and operability and environmental impacts. It also discusses Victory in the context of the UK's Net Zero target. Note, the NSTA (previously OGA) provided its non-objection to the selected concept on 28th July 2021.

2.2 Option Selection Process

2.2.1 Field Development Concept Options

Tie-Back Options

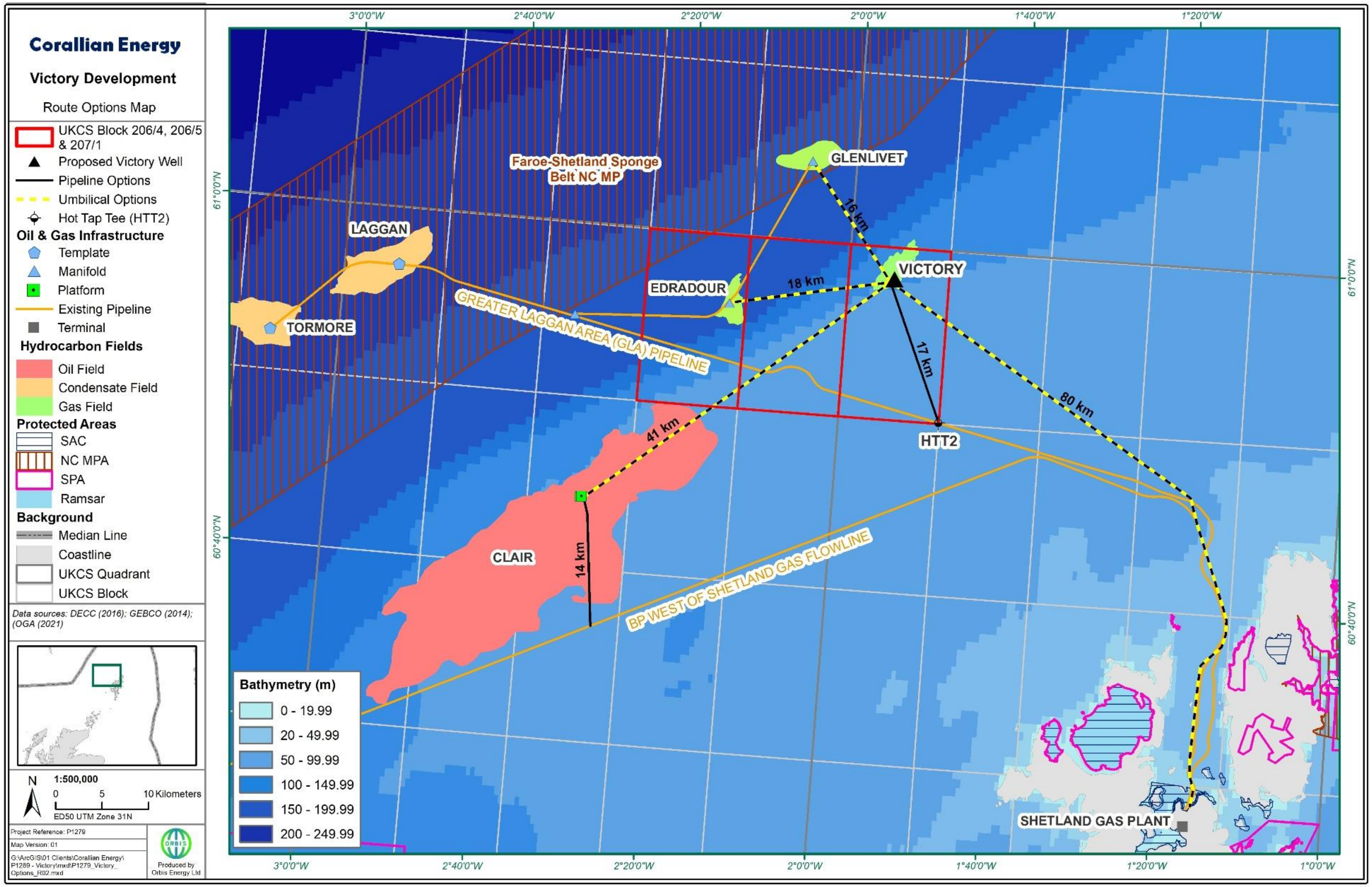
Initial technical studies confirmed that the optimum development option for Victory in terms of economics, risk and environmental impact is via a single well subsea tie-back to existing infrastructure. An initial screening exercise was conducted to identify potential export routes. This concluded that gas from Victory could potentially be exported via two pre-existing infrastructure systems; either the TotalEnergies' operated Greater Laggan Area (GLA) pipelines or the BP operated West of Shetland Pipeline System (WoSPS); or alternatively via a new, dedicated system for Victory alone. Eight subsea tie-back options were subsequently identified as potentially viable routes, as detailed in Table 2.1 and illustrated in Figure 2.1.

Table 2.1: Victory Field Development Concept Options

Concept No.	Pipeline Route[1]	Control Route	Assessed Further
Option 1	Tie-back to the GLA pipeline Hot Tap Tee 2 (**HTT2**) via a ca. 17 km, 14 inch pipeline	Control from the **Edradour** subsea manifold via a 18 km umbilical	Yes
Option 2	Tie-back to the **Clair Ridge Platform** via a 41 km, 14 inch pipeline and onwards to the WoSPS via a 14 km, 12 inch pipeline	Control from the **Clair Ridge Platform** via a 41 km umbilical	Yes
Option 3	Tie-back to the **Shetland Gas Plant (SGP)** via an 80 km, 14 inch pipeline	Control from the **Edradour** subsea manifold via a 18 km umbilical	Yes
Option 4	Tie-back to the **SGP** via an 80 km, 14 inch pipeline	Control from the **SGP** via an 80 km umbilical	Yes
Option 5	Tie-back to the **Edradour** subsea manifold via a 18 km, 14 inch pipeline	Control from the **Edradour** subsea manifold via a 18 km umbilical	No
Option 6	Tie-back to the **Glenlivet** subsea manifold via a 16 km, 14 inch pipeline	Control from the **Glenlivet** subsea manifold via a 16 km umbilical	No
Option 7	Tie-back to the GLA pipeline **HTT2** via a ca. 17 km, 14 inch pipeline	Control from the **Glenlivet** subsea manifold via a 16 km umbilical	No
Option 8	Tie-back to the **SGP** via an 80 km, 14 inch pipeline	Control from the **Glenlivet** subsea manifold via a 16 km umbilical	No

[1] Note, the concept selection study assumed a 12 inch gas export pipeline. Post-concept studies undertaken by Corallian have selected a 14 inch pipeline as detailed above.

Figure 2.1: Victory Field Development Concept Options



Concept Options Scoped Out From Further Assessment

Four of the identified eight options (options 5 to 8) were subsequently scoped out from detailed assessment due to technical reasons.

A common pipeline and umbilical route from Victory back to the Edradour or Glenlivet subsea manifolds (options 5 and 6), were discounted early on due to the following issues:

- The existing 12-inch in-field pipelines between Glenlivet and Edradour to the main GLA 18-inch tie-in point are too small to accept the anticipated combined flow from the Glenlivet, Edradour and Victory fields, as well as the yet to be developed “Glendronach” field (26/04a- 4 gas discovery);
- The increase in water depth from Victory (169 m) to Edradour (304 m) or Glenlivet (>400 m) would seriously constrain Victory production rates and potentially cause flow assurance issues in the pipeline;
- Flowing production fluids from Victory into the Glenlivet / Edradour pipelines would significantly back-out production from the Glenlivet and Edradour fields, due to their reservoir pressures being below that of Victory at the time of first gas from Victory.

All the above referenced factors combined would ultimately prevent recovery being maximised from Edradour, Glenlivet and Victory and the impact on Victory was considered large enough to potentially render the project uneconomic.

The possibility of expanding the control system from Glenlivet instead of Edradour for the pipeline tie-back routes to the HTT2 and the SGP was also considered given the shorter distance of umbilical which would be required (16 km versus 18 km). However, as the Glenlivet manifold is located in much deeper water, within a marine protected area and has significantly worse seabed conditions (high frequency of glacial boulders) versus the Edradour route, options 7 and 8 was also discounted.

Following the scoping out of options 5 – 8, the remaining options (1 -4) were presented in the Victory concept selection study (Corallian, 2021), submitted to the NSTA in May 2021.

Potential Environmental Impacts Associated with the Remaining Concept Options

The differences in environmental impact between the four remaining concepts (options 1 -4) are largely driven by:

- The area of seabed disturbed by the installation of the pipeline and umbilical;
- The quantity of materials used in manufacturing the pipeline and to a lesser extent, the umbilical; and
- The number of vessel days required to install the subsea infrastructure offshore.

Note, for comparison purposes during the concept selection phase, it has been assumed that the installation method for the pipeline and umbilical for all concept options is trench and burial.

Drilling and completing the Victory subsea development well and installing the wellhead and manifold will have a similar environmental impact for each of the concept options.

Operationally there is also little difference in the environmental impact, including greenhouse gas emissions, between options 1, 3 and 4 as processing of the Victory production fluids for all these options will occur onshore at the SGP. It is, however, recognised that the longer pipeline export route associated with options 3 and 4 will result in an increased number of vessel days, and therefore atmospheric emissions, attributed to pipeline inspection surveys throughout the field life.

For option 2, BP has since advised that tie-back to the Clair Ridge platform is not operationally viable as the asset does not have the capacity to handle Victory’s flow rates or supply MEG to the Victory wellhead. Major modifications would therefore be required to the Clair Ridge platform to accommodate Victory. Additionally, BP has a full platform drilling programme ongoing until 2028, which would prevent modification work to be undertaken prior to this date.

The environmental impact relating to decommissioning would also be similar for all options. The well would be disconnected from its respective subsea architecture, plugged and abandoned, the wellhead and casings cut at a depth below the mudline and the WHPS removed. All subsea infrastructure will be depressurised and flushed to remove residual hydrocarbons and chemicals and left flooded with seawater prior to abandonment, with any contaminated fluids flushed back to the SGP for treatment or flushed downhole. The subsea structures, such as the pigging skid and tie-in / protection structures would be removed, with the piles cut at a depth below the mudline to remove any obstructions on the seabed. As the pipeline and umbilical will be buried it is assumed they will be disconnected with their ends cut back and buried to ensure there are no obstructions on the seabed.

In addition, none of the options through the GLA system (options 1, 3 and 4) would prevent the Victory field from being repurposed for carbon capture and storage. For option 2, Clair Ridge has a much longer field life than Victory, therefore potentially preventing the repurposing of the Victory infrastructure.

The comparison discussion below therefore focuses on the differences between the options during the installation phase of the project. For completeness, option 2 has been included, although operationally this is no longer considered to be a viable solution.

Comparison of Seabed Disturbance

The area of seabed disturbance associated with the pipeline and umbilical installation for each concept option is presented in Table 2.2. It can be seen from this that Option 1 results in the least amount of seabed disturbance (0.35 km^2). In contrast, the footprints for Options 2, 3 and 4 are 1.6, 2.8 and 2.3 times larger respectively than for Option 1.

Table 2.2: Comparison of Seabed Disturbance Areas from Pipeline and Umbilical Installation

Concept Option	Approx. Length of Pipeline (km)	Approx. Length of Umbilical (km)	Estimated Area of Seabed Disturbed [1]	
			m^2	km^2
Option 1: Tie-back to the GLA pipeline HTT2 (Umbilical to Edradour)	17	18	350,000	0.35
Option 2: Tie-back to the Clair Ridge Platform (with control from same) [2]	55	41	550,000	0.55
Option 3: Tie-back to the Shetland Gas Plant (Umbilical to Edradour)	80	18	980,000	0.98
Option 4: Tie-back to the Shetland Gas Plant (with control from same) [2]	80	80	800,000	0.80

Notes:
[1] It is assumed that the seabed disturbance caused by pipeline and / or umbilical installation activities would occur within a 10 m working corridor.
[2] For options 2 and 4 it is assumed that the umbilical would be installed in a common trench and/or rock dumping corridor to the pipeline.

Comparison of Atmospheric Emissions

The atmospheric emissions associated with the manufacturing of steel pipe for each concept option are presented in Table 2.3. It can be seen from this that the emissions associated with the manufacturing of steel pipe for Option 1 are significantly smaller than for the other options, given the shorter length of pipeline required. In contrast, the carbon dioxide (CO_2) emissions associated with Option 2 are 2.4 times larger than for Option 1, and the CO_2 emissions associated with Options 3 and 4 are 3.3 times larger.

Table 2.3: Comparison of Atmospheric Emissions associated with the Manufacture of Steel Pipeline

Concept Option	Approx. Length of Pipeline (km)	Weight of Steel (tonnes)	Emission Generated During Manufacturing [1]		
			CO_2 (tonnes)	NOx (tonnes)	SOx (tonnes)
Option 1: Tie-back to the GLA pipeline HTT2	17	3,000	5,667	10.5	16.5
Option 2: Tie-back to the Clair Ridge Platform	55	7,200	13,601	25.2	39.6
Option 3 and 4: Tie-back to the SGP	80	9,900	18,701	34.7	54.5

[1] Emission factors taken from IoP (2000)

The control umbilical required for each of the concept options will likely have an outer double sheath of plastic sandwiching corrosion-resistant steel wire reinforcement, protecting an inner core, likely to include copper-cored, insulated electric cables, fibre-optic cables, hydraulic supply tubes and chemical (MEG) injection tubes. Materials for the umbilical are therefore mostly comprised of steel, plastic and copper, with Options 1 and 3 requiring less materials than the other options given the shorter length of umbilical required (see Table 2.4). As such, the manufacture of the umbilical for Options 2 and 4 will have a greater environmental impact in terms of atmospheric emissions of 2.3 to 4.4 times respectively in relation to Options 1 and 3.

Table 2.4: Comparison of Atmospheric Emissions associated with the Manufacture of Umbilical

Concept Option	Approx. Length of Umbilical (km)	Weight of Umbilical (tonnes)				CO_2 Emissions Generated (tonnes) [1, 2]
		Total	Steel	Plastic	Copper	
Options 1 & 3: Umbilical to Edradour	18	16.2	8.1	7.6	0.5	40.9
Option 2: Umbilical to Clair Ridge Platform	41	37	18.5	17.4	1.1	93.3
Option 4: Umbilical to SGP	80	72	36	33.8	2.2	181.8

[1] Steel and copper emission factors from IoP (2000) i.e. 1.889 kg CO_2/kg of steel, 7.175 kg CO_2/kg of copper.
[2] Plastic emission factors from Cushman-Roisin et al. (2021) i.e. 2.9 kg CO_2/kg of plastic.

Atmospheric emissions will also be generated from the combustion of hydrocarbons for power generation by the various vessels required to install the subsea infrastructure. Table 2.5 provides an estimate of the atmospheric emissions generated for each concept option based on the number of vessel days predicted to be required to install the infrastructure (note, a worst case installation scenario was considered for all options whereby the pipeline and umbilical are surface laid (?on an installed carpet of rock, with rock deposited on top). It can be seen from this that the emissions generated during the installation of the infrastructure required for Option 1 are significantly smaller than for the other options given the shorter length of pipeline and umbilical required.

Table 2.5: Comparison of Atmospheric Emissions associated with the Installation of the Infrastructure

Concept Option	Estimated Vessel Days	Total Fuel Used (tonnes) [1]	Emissions Generated During Installation Activities [2]		
			CO_2 (tonnes)	NOx (tonnes)	SOx (tonnes)
Option 1: Tie-back to the GLA pipeline HTT2 (Umbilical to Edradour)	112	2,460	7,872	146	9.7
Option 2: Tie-back to the Clair Ridge Platform (with control from same)	160	3,360	10,752	200	13.4
Option 3: Tie-back to the SGP (Umbilical to Edradour)	203	4,250	13,600	252	17.0
Option 4: Tie-back to the SGP (with control from same)	229	4,800	15,360	285	19.2

[1] Based on reported consumption rates for different type of vessel involved in subsea infrastructure installation (e.g. pipelay vessels, tug boats) taken from IoP (2000).

[2] Emission factors taken from DECC (2008).

In summary, from an environmental perspective, Option 1, the subsea tie-back to the GLA pipeline with control from Edradour, has the smallest footprint on the seabed and generates the lowest quantity of atmospheric emissions from both manufacturing of materials (as it uses the least amount of steel, plastic and copper) and from the vessels required to install the subsea infrastructure.

Overall Comparison of Options

Table 2.6 provides a summary of the other key conclusions drawn from the Victory concept selection study (Corallian, 2021) for each of the four concept options evaluated, alongside the potential environmental implications during the installation phase, as discussed above.

For option 2, BP has advised that tie-back to the Clair Ridge platform is not a viable option as the asset does not have the capacity to handle Victory's flow rates or supply MEG to the Victory wellhead.

For options 1, 3 and 4 there is little difference in the environmental impact, including the greenhouse gas emissions produced, during the production phase as processing of the Victory fluids for all these options will occur onshore at the SGP. Pressure and flow assurance issues have been jointly modelled by Corallian and the GLA partners and have led, amongst other things, to one of the existing 18" GLA pipelines being dedicated to Victory. Backout will also be minimised by the dedication of one of the GLA pipelines to Victory. Hydrates / corrosion are mitigated by the chemicals supplied by the GLA owners.

The decommissioning strategy for all options routed through the GLA infrastructure (options 1, 3 and 4) is similar and would allow for the Victory field to be re-purposed for carbon capture and storage at a later date, after cessation of production. For option 2, Clair Ridge has a much longer field life than Victory, therefore potentially preventing the repurposing of the Victory infrastructure.

In conclusion, it can be seen from Table 2.6 that the concept of a tie-back to the GLA system (Option 1) is superior to that of a tie-back to the WoSPS (Option 2 – which is operationally not viable) or the SGP (Options 3 and 4).

Tie-back to the GLA system via HTT2 is preferred as it is the simplest and best defined of the options, carries the lowest risk, can be executed at the lowest cost and with the greatest economic return and has the lowest environmental impact. The tie-back is the shortest distance and has the lowest number of operational days offshore, making it least susceptible to weather risk.

In addition, this tie-back option is considered to be the most efficient export route for Victory gas and may also prolong the life of the GLA system and the SGP by adding significant additional resources to this existing infrastructure. The Victory gas stream will extend the life of the GLA system by an estimated one to two years if “Glendronach” (gas discovery, 206/04a – 4 well) is not developed by TotalEnergies, and by up to two to three years if “Glendronach” is developed, thus increasing the recovery of economically viable resources from currently producing fields in the region.

Table 2.6: Comparison Summary of Victory Development Concept Options

Concept Option	New Pipeline and Control Infrastructure Required	Environmental Impacts			Estimated Project Cost (£million)	Schedule (1st Gas Achieved)	Recoverable Resources (billion cubic feet of gas) [2]	Installation and Operational Considerations	Re-use / re-purposing of infrastructure
		Seabed Disturbance (km^2)	CO_2 Emissions (tonnes) [1]	Direct Impact on Protected Area					
Option 1: Tie-back to the GLA pipeline HTT2 (Umbilical to Edradour)	c.17km 14-inch production pipeline between Victory and the HTT2 tie-in point 18km control umbilical from the Edradour well to Victory	0.35	13,580	No	88	Q4 2023	217	The GLA facilities were designed to accommodate gas from third parties wishing to enter the system for transportation and/or processing. The control system was also designed to be expanded to allow future tie-ins. The pipeline operates hydrocarbon and water wet, so no processing is required of well stream fluids prior to entry into the pipeline. Utilising a dedicated line for Victory from the GLA system, has the advantage of minimising the backout of existing production streams. No modifications to the SGP process systems are envisaged.	Allows for the Victory field to be re-purposed for carbon capture and storage after cessation of production
Option 2: Tie-back to the Clair Ridge Platform (with control from same)	41km 14-inch production pipeline between Victory and Clair Ridge platform 14km 12-inch pipeline from Clair Ridge platform to the WoSPS pipeline tee 41km control umbilical from the Clair Ridge platform to Victory	0.55	24,446	No	164	Later than Q4 2028	215	Not operational viable as the asset does not have the capacity to handle Victory's flow rates or supply MEG to the Victory wellhead. The WoSPS operates at a higher pressure and is a dry gas system, precluding a direct tie-in of Victory into the pipeline. Major modifications would be required to the Clair Ridge platform, necessitating shutdown or partial shutdown of the platform and potentially making this option prohibitively expensive. Uncertainty around the available export compression capacity of the Clair Ridge platform.	Unlikely to allow for the Victory field to be re-purposed for carbon capture and storage after cessation of production

Concept Option	New Pipeline and Control Infrastructure Required	Environmental Impacts			Estimated Project Cost (£million)	Schedule (1st Gas Achieved)	Recoverable Resources (billion cubic feet of gas) [2]	Installation and Operational Considerations	Re-use / re-purposing of infrastructure
		Seabed Disturbance (km^2)	CO_2 Emissions (tonnes) [1]	Direct Impact on Protected Area					
Option 3: Tie-back to the SGP (Umbilical to Edradour)	80km 14-inch production pipeline between Victory and the SGP 18km control umbilical from the Edradour well to Victory	0.98	32,342	Yes	175	Q4 2024	209	Avoids any back-out of production from the existing GLA producing wells and provides the capacity to flow Victory at maximum rates. Some modifications required at the SGP. The area is congested with a number of existing pipelines already approaching the SGP and Sullom Voe along the same corridor. Tie-in to the SGP is considered to be the highest risk of all concept options considered; the tie-back is the longest distance and has the highest number of operational days offshore, making it the most susceptible to weather risk.	Allows for the Victory field to be re-purposed for carbon capture and storage after cessation of production
Option 4: Tie-back to the SGP (with control from same)	80km 14-inch production pipeline between Victory and the SGP 80km control umbilical from SGP to Victory	0.80	34,243	Yes	193	Q4 2024	209		

[1] Based on emissions generated during manufacturing of the pipeline and umbilical and from the vessels required to install the infrastructure (see Tables 2.2 to 2.4 above).
[2] Recoverable resources of 209 – 217 BCFG quoted for options 1 to 4 above were refined during post-Concept studies to 179 BCFG of 2C Contingent Resources.

2.2.2 Drilling Options

With regards to the drilling operation and the characteristics of the proposed Victory development well, several options have been evaluated as discussed below.

Well Location and Design

The surface location of the proposed Victory well has been selected based on the subsurface structure. The well is due to be drilled near the crest of the mapped reservoir and 81 m updip of the original discovery well (207/1- 3).

The well design is detailed in Section 3.3.4 and allows for a 90 m long inclined section through the reservoir with a 72 m long gravel packed lower completion. A vertical well was investigated, but modelling indicated it would not provide a sufficiently long enough production plateau. In addition, the shorter reservoir section contacted by a vertical well versus a deviated well would increase the drawdown pressure across the reservoir / wellbore interface, potentially increasing the risk of reservoir damage and / or sand production. The potential minor plateau length extension (1 -2 months) afforded by a horizontal well was not considered sufficient enough to offset the significantly increased complexity and risk of that well design.

The use of a slim hole design was also considered, but was found not to be feasible in this instance as it would not permit the installation of a large enough diameter completion to ensure the high, sand-free, gas production rates required to maximise economic recovery from the field. In addition, the well is shallow with a total measured depth 1,461m, limiting any benefit of slim hole drilling.

Drilling Rig

The water depth at Victory (169 m) precludes the use of a dynamically-positioned (DP) semi-submersible rig, as the riser would not be long / flexible enough for the rig to safely move around whilst on station. Only a moored semi-submersible rig can be held stationary enough in this water depth to safely drill the well.

Drilling Mud and Disposal of Drill Cuttings

Drilling muds essentially consist of clay suspended in a liquid phase to which a weighting agent (usually the mineral barite) together with a variety of other chemical additives has been added. The choice of mud weight (specific gravity) and base fluid type (water-based or low-toxicity oil-based) is largely dependent on the nature of the formations to be drilled.

For the proposed Victory well, seawater and sweeps will be used to drill the top two hole sections (36" and 17½"), with water-based mud (WBM) used to drill the remainder of the well sections (12¼" and 8½"). WBM is made from a base fluid which may be fresh water, seawater, brine, saturated brine, or a formate brine. These WBM systems incorporate natural clays in the course of the drilling operation and any chemicals that are added to WBM are generally of low environmental risk. In contrast, oil-based mud contains a number of chemical additives, as well as the oil-base, that are likely to have an adverse impact on the marine environment and may be listed as candidates for substitution.

Options for the disposal of WBM drill cuttings include discharge to sea, reinjection and skip and ship for disposal onshore. For the Victory well, cuttings reinjection is not a feasible option, as there is no available well to inject the cuttings into. In addition, skip and ship is not preferred due to the large volume of cuttings that would need to be transported, the storage of which requires a large amount of deck space on the drilling rig. Although the onshore disposal of cuttings would have less environmental effects on the marine environment; transporting the cuttings to shore will result in additional transit emissions and the potential effects of onshore waste disposal, as well as additional costs for transport and possible operational delays.

2.2.3 Pipeline and Umbilical Installation Options

The options initially considered for installation of the pipeline and umbilical installation include

- Option 1: Trench and burial along the entire length of the pipeline and umbilical;

- Option 2: Rock protection used both underneath (pre-installation) and on top of the pipeline and umbilical (post lay).
- Option 3: Creation of pre-cleared corridors from which residual boulders greater than 0.5 m are removed, with rock protection used on top of the pipeline and umbilical once laid.

Detailed engineering surveys have yet to be undertaken for the proposed development concept option and are currently not scheduled to occur until the summer of 2023. However, several boulders were observed on the surface of the seabed during the Victory environmental baseline survey. A large number of contacts/boulders greater than 1 m in length were recorded along the umbilical route to Edradour (1,203), with fewer along the proposed pipeline route (56) and very few in the vicinity of the proposed development well location (37). Figure 2.2 and Figure 2.3 show the frequency of these features along the proposed pipeline route and umbilical route, respectively.

Ploughing and backfilling tools are typically capable of accommodating boulders or other isolated obstructions up to 0.5 m in dimension. Based on the experience TotalEnergies gained during the design and installation of the Edradour and Glenlivet pipelines, also located in this area of the West of Shetland, and on the assumption that the number of boulders on the surface are indicative of the seabed condition beneath the surface, the trenching of the pipeline and umbilical (i.e. option 1) will not be a viable option as there are boulders along the routes that are in excess of what can be handled by a plough.

Figure 2.2: Boulders along the Proposed Pipeline Route to HTT2 (Victory is at KP0 - red dot = km mark and orange / yellow dots = boulder)

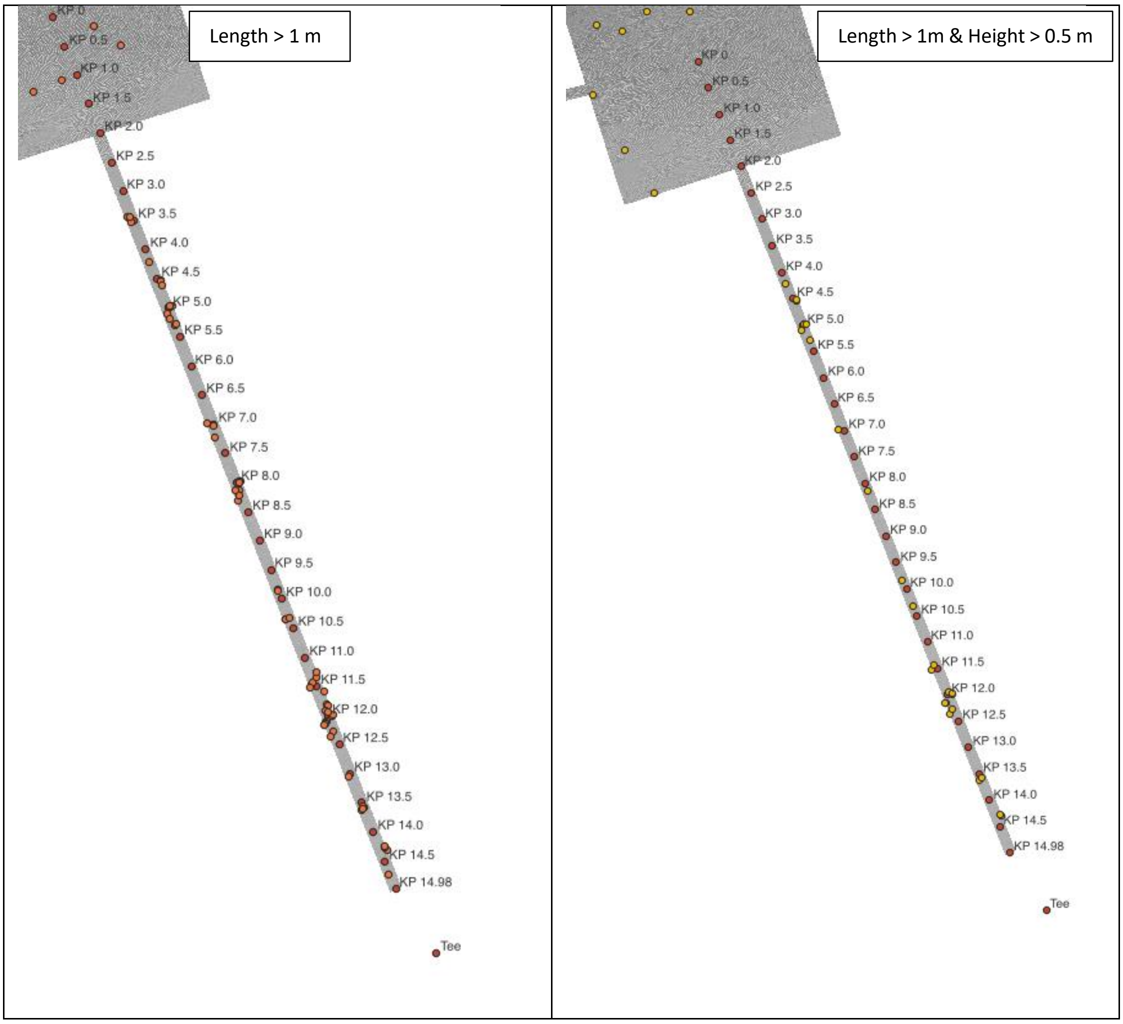
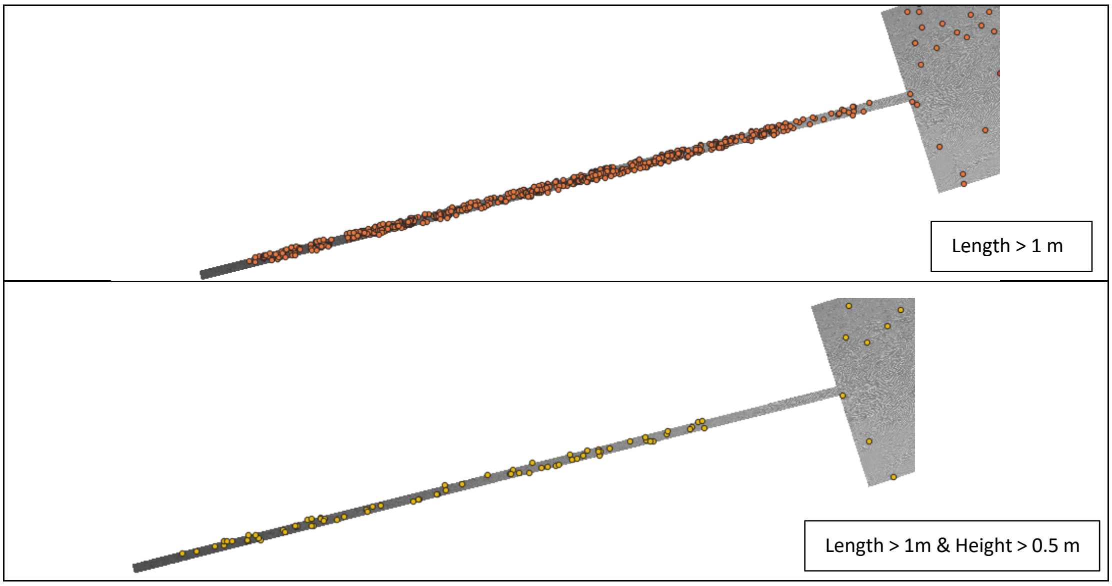
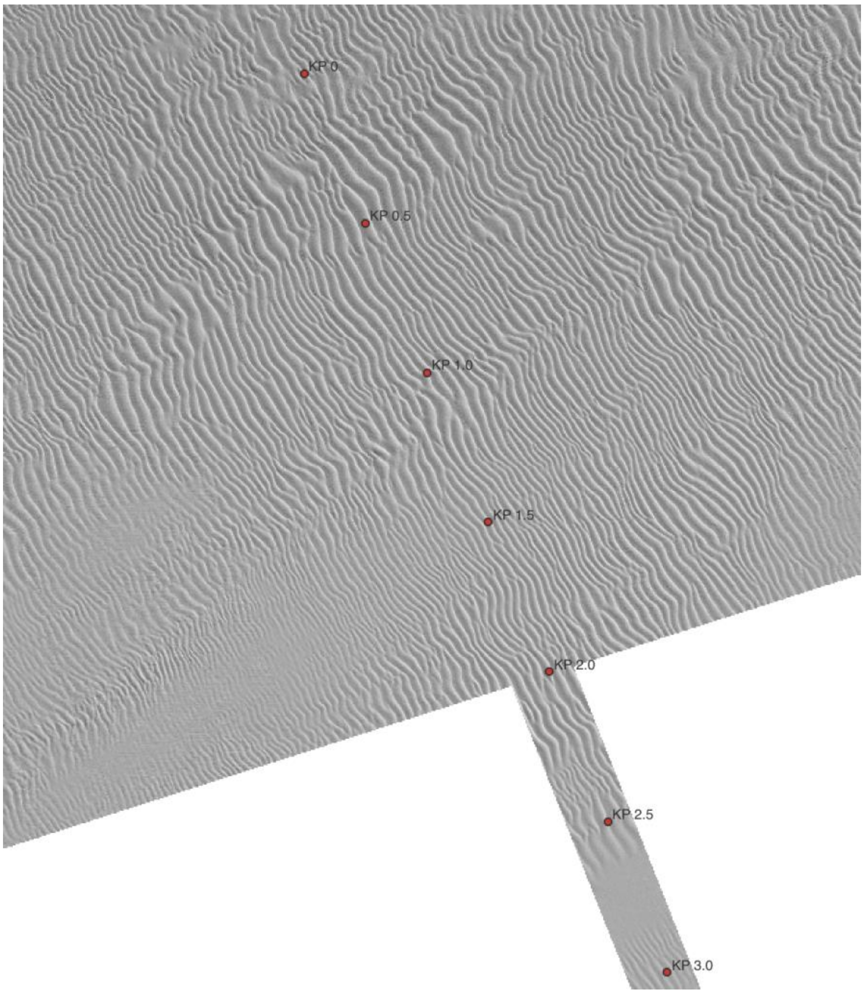


Figure 2.3: Boulders along the Proposed Umbilical Route to Edradour



Large megaripples or sand waves (approximately 15 to < 50 m) were also observed at the Victory location and along the initial part of the pipeline route, for the first 2.5 km (see Figure 2.4). Although there are no apparent surface boulders along this section of the pipeline route, post-lay ploughs are unlikely to be able to be used in this area due to the ploughing limits associated with slopes.

Figure 2.4: Sand waves along the Initial Proposed Pipeline Route (Victory is at KP0)



Until the results of the detailed engineering surveys are available, there is still uncertainty over the pipeline and umbilical installation method, however option 2 (i.e. lay rock carpet, lay pipeline and umbilical on rock carpet and deposit rock on top) is worst case in terms of environmental impact and has therefore been assessed in the impact assessment chapters of this ES document.

An optimum route through the sand wave area will be investigated and, as a worst case, it is currently assumed a mass flow excavator will be used post lay to reduce the amount of rock deposit required.

In addition, during the detailed engineering studies the option to use a weighted pipeline will be investigated, which may reduce the worst case quantity of rock to be deposited, as detailed in Section 3.4.4.

2.3 Victory in the Context of Net Zero

2.3.1 Introduction

The Climate Change Act 2008 (as amended) commits the UK government by law to reducing greenhouse gas (GHG) emissions by at least 100% of 1990 levels (net zero) by 2050 and requires the government to set legally-binding ‘carbon budgets’ to act as stepping stones towards the 2050 target. These carbon budgets restrict the total amount of GHG that the UK can emit over five-year periods, ensuring continued progress towards the UK’s long-term climate target.

Nationally Determined Contributions (NDCs) are commitments made by parties to the Paris Agreement. They show how parties intend to reduce their GHG emissions to meet the temperature goal of the Paris Agreement. In 2020, the UK communicated to the UN Framework Convention on Climate Change (UNFCCC) its NDC pledge to reduce UK emissions by at least 68% by 2030 on 1990 levels and in June 2021, the UK government set in law the sixth carbon budget (CB6), limiting the volume of greenhouse gases emitted from 2033 to 2037. CB6 reduces emissions by approximately 78% by 2035 compared to 1990 levels.

Note, Scotland has committed to becoming a Net Zero society by 2045, five years ahead of the rest of the UK, with interim targets of 75% by 2030 and 90% by 2040.

Targets have also been set for the offshore oil and gas sector to have an absolute reduction in production emissions of 10% by 2025, 25% by 2027, and 50% by 2030, against a 2018 baseline, on the pathway to net zero by 2050. This includes industry’s direct GHG emissions arising from upstream exploration and production activities on the UKCS and onshore processing, including CO_2, methane and other GHG emissions.

The concept selection process for the proposed Victory development has considered these targets along with relevant requirements relating to the oil and gas industry as set out in key UK strategy and policy documents relating to energy security, low carbon UK gas and the transition to Net Zero. An overview of how Victory project plans to meet relevant energy transition and Net Zero commitments and expectations is provided in Table 2.7.

Table 2.7: Victory Compliance with Key Energy Transition and Net Zero Commitments & Expectations

Strategy / Policy Document	Key Commitments and Expectations Relating to the Oil and Gas Industry	Addressed by the Victory Project	ES Reference
The UK Government's Energy White Paper: Powering our Net Zero Future (HM Government, 2020)	Working with the regulators, we will drive the reduction of GHG emissions from all offshore oil and gas operations to make the UK continental shelf a net zero basin by 2050. We will commit the UK to the World Bank's 'Zero Routine Flaring by 2030' initiative and will work with regulators towards eliminating this practice as soon as possible in advance of this date. We will support the UK oil and gas sector to repurpose its existing infrastructure in support of clean energy technologies. We will take powers to ensure we maintain a secure and resilient supply of fossil fuels during the transition to net zero emissions.	The chosen field development option has the lowest emissions of GHG relative to the alternative concepts. Production from Victory will not change the current operating conditions at SGP with respect to flaring. After cessation of production at Victory, the field has the potential to be re-purposed for carbon capture and storage. All gas produced from the Victory field will flow to the SGP and will be used domestically and not exported.	Section 2.2.1 Section 3.5.2 Section 2.3.4 Section 2.3.2
The OGA Strategy (OGA, 2020a)	Relevant persons must, in the exercise of their relevant activities, take the steps necessary to: a. secure that the maximum value of economically recoverable petroleum is recovered from the strata beneath relevant UK waters; and, in doing so, b. take appropriate steps to assist the Secretary of State in meeting the net zero target, including by reducing as far as reasonable in the circumstances greenhouse gas emissions from sources such as flaring and venting and power generation, and supporting carbon capture and storage projects.	Production from the Victory field will processed onshore at the SGP with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the Victory development. Victory will reduce the overall CO_2 Emission Intensity (EI) of gas produced through the SGP resulting in a relatively low EI compared to other existing domestic production source and imported LNG. Following clean-up, a main well flow test will be undertaken via the rig to obtain reservoir information and fluid samples. The well test will be designed to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely. After cessation of production at Victory, the field has the potential to be re-purposed for carbon capture and storage.	Sections 2.3.2 to 2.3.4

Strategy / Policy Document	Key Commitments and Expectations Relating to the Oil and Gas Industry	Addressed by the Victory Project	ES Reference
OGA Stewardship Expectation 11 - Net Zero (OGA, 2021a)	Expectation that the Upstream Oil and Gas Industry reduce, as far as reasonable in the circumstances, GHG emissions from all aspects of their upstream operations. This includes the development of new hydrocarbon projects; existing producing assets; the abandonment and decommissioning of fields; and the progression of potential energy integration/net zero solutions to assist the Secretary of State in meeting the Net Zero Target. During the development phase, industry shall demonstrate delivery of this expectation via: i. Assessment phase of field development planning to demonstrate consideration and economic assessment of GHG Emissions Reduction Action Plans, such as: • Low GHG emission operations • Zero routine non-safety related flaring/venting • Gas recovery systems • Measurement of GHG emissions • Technology and digitalisation to reduce GHG emissions • Possibilities for Energy Hubs • Collaboration with peers in area ii. Quantification of GHG emissions of selected concept vs alternative concepts, to include: • Re-use/re-purposing of infrastructure and facilities • Evaluation of GHG emissions impacts on selected host infrastructure iii. Authorisation phase of field development planning demonstrates: • A forecast of the field's energy consumption and GHG emissions • The selection of energy efficient equipment for power generation • The incorporation of accurate instrumentation for the measurement of GHG emissions	The chosen field development option has the lowest potential impact on the environment and the lowest emissions of GHG relative to the alternative concepts. Drilling and installation operations will aim to reduce vessel days and fuel consumption to minimise GHG emissions. Following clean-up, a main well flow test will be undertaken via the rig to obtain reservoir information and fluid samples. The well test will be designed to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely. The SGP is a modern asset with low GHG intensity, with annual CO_2 emissions currently at 158,000 tonnes. The plant is run using a single compressor and generator. When production rates were greater (between 2017 and 2021), the plant used two compressors and generators, and CO_2 emissions were approximately 200,000 tonnes per annum. The addition of Victory is expected to require use of a twin-train operation and from Q4 2024 to Q4 2029, it is predicted that annual CO_2 emissions from the SGP will revert to around 200,000 tonnes, which gives an average EI through the life of Victory of 17 kg CO_2e/boe. Victory may also benefit from renewable sources of power and electrification of the SGP, which could further reduce the EI of gas produced through the SGP. Production from Victory will not change the current operating conditions at SGP with respect to flaring. After cessation of production at Victory, the field has the potential to be re-purposed for carbon capture and storage.	Section 2.2.1 Section 2.3.3 Section 2.3.2 Section 2.3.4

Strategy / Policy Document	Key Commitments and Expectations Relating to the Oil and Gas Industry	Addressed by the Victory Project	ES Reference
North Sea Transition Deal (BEIS, 2021a)	Aimed at delivering on the commitments set out in the oil and gas chapter of the government's Energy White Paper. In relation to supply decarbonisation, sector actions include: • Reduce emissions from oil and gas production by 10% by 2025, by 25% by 2027 and by 50% by 2030 (all relative to 2018 baseline), as measurable steps to a net zero basin by 2050. • Support the development of, and rapidly implement and follow, the OGA's Net-Zero Asset Stewardship Expectation, to encourage emissions reductions from both existing and new developments. • Work with the government, OPRED, and the OGA on consistent reporting structures and frameworks to minimise the reporting burden and enable clearer monitoring of progress. • Phasing out of routine flaring and venting with a reduction of 30%, over and above natural decline, improving gas recovery and implementing new flare management plans. Work to accelerate the commitment to support the World Bank Zero Routine Flaring by 2030 initiative. • Earlier alignment of UKCS with global methane standards through the implementation of a Methane Action Plan, incorporating enhancement quantification and measurement, followed by systematic programme of reduction of platform and fugitive emissions. • Collaborative investment in electrification of assets.	The chosen field development option has the lowest potential impact on the environment and the lowest emissions of GHG relative to the alternative concepts.	Section 2.2.1
		Drilling and installation operations will aim to reduce vessel days and fuel consumption to minimise GHG emissions. Following clean-up, a main well flow test will be undertaken via the rig to obtain reservoir information and fluid samples. The well test will be designed to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely.	Section 2.3.3
		The SGP is a modern asset with low GHG intensity, with annual CO_2 emissions currently at 158,000 tonnes. The plant is run using a single compressor and generator. When production rates were greater (between 2017 and 2021), the plant used two compressors and generators, and CO_2 emissions were approximately 200,000 tonnes per annum. The addition of Victory is expected to require use of a twin-train operation and from Q4 2024 to Q4 2029, it is predicted that annual CO_2 emissions from the SGP will revert to around 200,000 tonnes, which gives an average EI through the life of Victory of 17 kg CO_2e/boe. Victory may also benefit from renewable sources of power and electrification of the SGP, which could further reduce the EI of gas produced through the SGP. Production from Victory will not change the current operating conditions at SGP with respect to flaring.	Section 2.3.2
		After cessation of production at Victory, the field has the potential to be re-purposed for carbon capture and storage.	Section 2.3.4

<table>
<tr><th>Strategy / Policy Document</th><th>Key Commitments and Expectations Relating to the Oil and Gas Industry</th><th>Addressed by the Victory Project</th><th>ES Reference</th></tr>
<tr><td>The UK Government's Net Zero Strategy: Build Back Greener (HM Government, 2021a)</td><td>Sets out clear policies and proposals for keeping the UK on track for the UK's carbon budgets and 2030 NDC and outlines the UK's vision for a decarbonised economy in 2050. With regards to fuel supply, key commitments to transitioning to a low carbon future include:
• Work with stakeholders to address barriers to electrification of oil and gas production by Q4 2022 and continue to drive down routine flaring and venting.
• Regulate the oil and gas sector in a way that minimises GHG emissions, notably through the revised OGA strategy, which empowers the OGA to assess operators' plans to reduce their emissions levels against effectively a net zero test, and establish a climate compatibility checkpoint for future licensing on the UKCS.</td><td>Victory may benefit from renewable sources of power and electrification of the SGP, which could further reduce the EI of gas produced through the SGP.
Production from Victory will not change the current operating conditions at SGP with respect to flaring. Following clean-up, a main well flow test will be undertaken via the rig to obtain reservoir information and fluid samples. The well test will be designed to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely.</td><td>Section 2.3.2
Section 2.3.2</td></tr>
<tr><td>UK Carbon Budgets</td><td>The following six carbon budgets have been put into law and run up to 2037. It is proposed that the Victory field will be developed during CB4 with production operations occurring over an eight year period from 2024 to 2031 in CB4 and CB5.
<table>
<tr><th>Carbon Budget</th><th>Level (MtCO2e)</th><th>Reduction below 1990 level</th><th>Met?</th></tr>
<tr><td>CB1 (2008 to 2012)</td><td>3,018</td><td>25%</td><td>Yes</td></tr>
<tr><td>CB2 (2013 to 2017)</td><td>2,782</td><td>31%</td><td>Yes</td></tr>
<tr><td>CB3 (2018 to 2022)</td><td>2,544</td><td>37% by 2020</td><td>On track</td></tr>
<tr><td>CB4 (2023 to 2027)</td><td>1,950</td><td>51% by 2025</td><td>Off track</td></tr>
<tr><td>CB5 (2028 to 2032)</td><td>1,725</td><td>57% by 2030</td><td>Off track</td></tr>
<tr><td>CB6 (2033 to 2037)</td><td>965</td><td>78% by 2035</td><td>Off track</td></tr>
</table></td><td>All offshore emissions from Victory are associated with the drilling, well completion, installation and commissioning of the Victory Development. These activities are planned during 2024 and, as a consequence, will occur in the 4th UK carbon budget period from 2023 to 2027. The total estimated Victory CO_2e emissions is 22,469 tonnes which is equal to less than 0.0012% of the UK budget, a very small component of the overall emissions in the UK.
During production, as the SGP is located onshore, the emissions arising at SGP as result of the Victory development are outside of the scope of this ES. However, SGP is a modern asset with low GHG intensity.</td><td>Section 9.3.1</td></tr>
</table>

Strategy / Policy Document	Key Commitments and Expectations Relating to the Oil and Gas Industry	Addressed by the Victory Project	ES Reference
British Energy Security Strategy (HM Government, 2022)	Recognises the importance of oil and gas to the transition and to our energy security, and that producing gas in the UK has a lower carbon footprint than importing it from abroad.	The Victory field development is a low carbon gas opportunity that can help contribute to energy security during the transition to Net Zero and decrease the UK's reliance on imported gas.	Section 2.3.2

2.3.2 Victory's Potential Contribution to Energy Security During the Transition to Achieve Net Zero

UK government forecasts show that oil and gas will continue to play an important role as the UK transforms from an economy based on fossil fuels to one based on clean energy. Domestic production still met 46% of the country's supply of gas in 2019, with the vast majority of this supplied from North Sea offshore production.

The Victory field has an estimated recoverable resource of 179 billion cubic feet of gas (P50), equivalent to 7% of the UK's annual natural gas consumption (i.e. 2,560 billion cubic feet in 2020).

It is proposed that gas from the Victory field will processed onshore at the SGP with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the development.

The SGP is a modern asset with low GHG intensity, with TotalEnergies taking measures in the past couple of years to further reduce GHG emissions; namely switching to single compressor train operation and, by reducing SGP power demand, allowing single Gas Turbine Generator operations. The net impact of these changes has achieved a saving of close to 50,000 tonnes of GHG emissions per year, with annual CO_2 emissions currently at 158,000 tonnes.

Historically, the average CO_2 Emission Intensity (EI) of gas produced through the SGP has been approximately 8 to 13 kg of CO_2 equivalent per barrel of oil equivalent (CO_2e/boe). The forecast production from the GLA fields, assuming the addition of production from the 206/04a- 4 gas discovery ("Glendronach"), and the Victory field from Q4 2024 to Q4 2029, is predicted to be approximately 60.4 million barrels of oil equivalent (mmboe). This volume is split approximately evenly between Victory and the other GLA fields. However, production from the GLA fields will decline through the future years resulting in the EI increasing. In addition, it is likely that the SGP will need to revert to a two compressor / generator train operation when Victory and "Glendronach" come onstream during the initial life of the fields. Annual CO_2 emissions from the SGP are therefore forecast to be around 200,000 tonnes (as it was previously between 2017 and 2021), which gives an average EI through the life of Victory of 17 kg CO_2e/boe. This forecast compares favourably to the average of 22 kg CO_2e/boe for domestic gas production and 59 kg CO_2e/boe for LNG imports; and a minimum of 18 kg CO_2e/boe for gas imported by pipeline via the Dutch and Belgian interconnectors (not traced to the point of origin) (OGA, 2020b). Note, TotalEnergies will be responsible for amending the SGP's ETS Permit to accommodate the Victory development.

Victory will produce most of its resource between 2025 and 2030. In 2025 the UK is forecast to fill between 26% and 40% of gas demand from existing fields and expected new field developments. By 2030 domestic production is forecast to fill between 15% and 33% of gross gas demand. All gas produced from the Victory field will flow to the SGP and will be used domestically and not exported. Therefore, the development of the Victory gas field will contribute to the security of the UK's gas supply, decreasing the reliance on imported gas which potentially has a much higher EI. As Victory will have a relatively low EI compared to existing domestic production sources, it is predicted that 5 kg CO_2e/boe could be saved by utilising Victory's gas resources. This potentially contributes a saving of 150,000 tonnes of CO_2 emissions over the life of the Victory field in comparison to gas production from existing fields in the UKCS. The savings are higher when compared to LNG imports.

In summary, Victory will reduce the overall EI of gas produced through SGP, providing lower carbon, indigenous gas during the transition to renewable energy, helping contribute to energy security and assist in the delivery of Net Zero UK carbon emissions by 2050.

In addition to the above, Victory may also benefit from renewable sources of power and electrification of the SGP, which could further reduce the EI of gas produced through the SGP. Project Orion (Opportunity Renewables Integration Offshore Networks) was initiated in 2020 by Shetland Island Council to transform Shetland into a green energy hub. The project aims to harness onshore and offshore wind power to electrify all offshore facilities and develop a large scale green hydrogen export business. Research studies and concept engineering will precede project investment, with part-electrification of complexes such as SGP and Sullom Voe by wind power potentially becoming available during the field life of Victory.

2.3.3 Minimising GHG during Development of the Victory Field

Corallian seeks to play its role in the transition to Net Zero by minimising GHG emissions generated during development of the Victory field. As discussed in Section 2.2.1, the chosen field development concept option has the lowest potential impact on the environment and the lowest emissions of GHG relative to the alternative concepts.

The single proposed development well has a robust design, with an open hole gravel pack completion for sand control, permanent downhole pressure gauge and flow meter, which should avoid the need for well intervention throughout the life of the Victory Field, preventing the production of further GHG emissions. The use of MEG, delivered by the umbilical negates hydrates.

The well will be located close to the crest of the Victory structure and should effectively sweep the entire gas resources, thereby avoiding the need for a second development well and associated GHG emissions.

During drilling and installation operations, key to minimising GHG emissions will be to reduce vessel days and fuel consumption. As such, Corallian proposes to adopt the following measures for Victory:

- Vessel mobilisation and demobilisation distances will be reduced, as far as practical;
- Where possible, activities will be scheduled to minimise waiting on weather;
- Opportunities to share supply boats with nearby operators will be explored to minimise vessel trips;
- Supplier's environmental footprints will be factored into the tender evaluation process.

In addition, well planning will look to minimise the use of materials, particularly cement. The use of 'green cement' will also be considered (cement which has been manufactured using techniques which minimise CO_2 emissions).

Well testing is unavoidable as it is required to clean out the wellbore, recover representative / uncontained samples of the reservoir fluid and confirm reservoir deliverability. Currently the only analysis of Victory gas comes from a single flowline sample taken during a drill stem test on well 207/01-3 in 1977. The well test will also confirm that the gravel pack completion is effective in controlling sand production. If the well is not cleaned-up, gas would be contaminated with drilling / completion fluid and would likely not meet entry-specification for the GLA system. Other chemicals and gravel flowback could also cause damage to the choke, flow meter and GLA infrastructure.

Clean-up will remove chemicals required for running the completion across the reservoir (brine). No additional chemicals are used for the clean-up, the well test or the test separator, other than glycol (MEG at ppm levels) for hydrate suppression at start-up / if required.

The well test and well clean-up activities will, however, be designed not only to achieve their goals but to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely.

The test duration will be across a total planned period of ten days, but with only three 6-hour flow periods and is therefore not classed as an extended well test. The test also involves shut-in and build-up periods to analyse reservoir pressure response.

2.3.4 Potential Re-Use of Victory Infrastructure

The Victory asset is being designed primarily for production of Victory gas; however, scoping studies performed under the Carbon Capture and Storage (CCS) Appraisal Project, particularly the selected Captain X / Captain Aquifer site, suggest that Victory facilities may be suitable for re-use for CCS after cessation of production. The Captain X site comprises re-use of the existing 78 km 16 inch pipeline from St Fergus to the decommissioned Atlantic-Cromarty fields, where two injection wells could deliver 3 million tonnes of CO_2 per annum for storage, with an additional well used as back-up.

The Victory reservoir has excellent porosity and permeability. The crest of the Victory reservoir is located at around 1,150 m subsea and post-production the reservoir pressure is likely to be a relatively low at around 120 bar. The existing GLA fields may be less suitable for CCS, being considerably deeper and at higher pressure than Victory, although if deployment of this technology becomes widespread it may be feasible to convert the entire GLA complex (including Victory) to CO_2 storage.

In the future, Sullom Voe oil terminal could potentially be used to import compressed CO_2 for a CCS project if this becomes a routine process within a wider CCS industry. The SGP and or Sullom Voe oil terminal could make use of their existing gas infrastructure to support the manufacture of blue hydrogen, the CO_2 by-product of which could be directed to a Victory CCS project.

Given the above, the casing programme for the proposed Victory development well has been designed so it is potentially suitable for future re-use as a CO_2 injection well and the well evaluation programme will include cement bond logging. The wellbore includes a 7" monobore completion from sandface to the wellhead, facilitating high production and injection rates. The completion tubing will be manufactured using a 13% chrome alloy, providing corrosion resistance over the interval where the CO_2 may contact water.

The remaining pipeline infrastructure, from wellhead to the SGP comprises carbon steel which is suitable for transporting CO_2 in dry gas or liquid phase, subject to inspection of the lines prior to use.

3 Victory Project Description

3.1 Development Concept

The Victory field will be developed via a single subsea well (207/01a-F) tied back to the existing, TotalEnergies operated, Greater Laggan Area (GLA) infrastructure. The GLA comprises four producing fields (Laggan, Tormore, Edradour, and Glenlivet) which are tied back to the onshore Shetland Gas Plant (SGP) via two 18 inch pipelines (see Figure 3.1). An 8 inch MEG pipeline and main umbilical run in parallel to the 18 inch pipelines from the SGP, terminating at the Tormore manifold. Production from the GLA fields is commingled and processed at the SGP. The liquids (condensates) are removed and piped to the nearby Sullom Voe oil terminal, while the gas is processed before being exported into the FUKA Pipeline via the SIRGE pipeline for distribution in the UK.

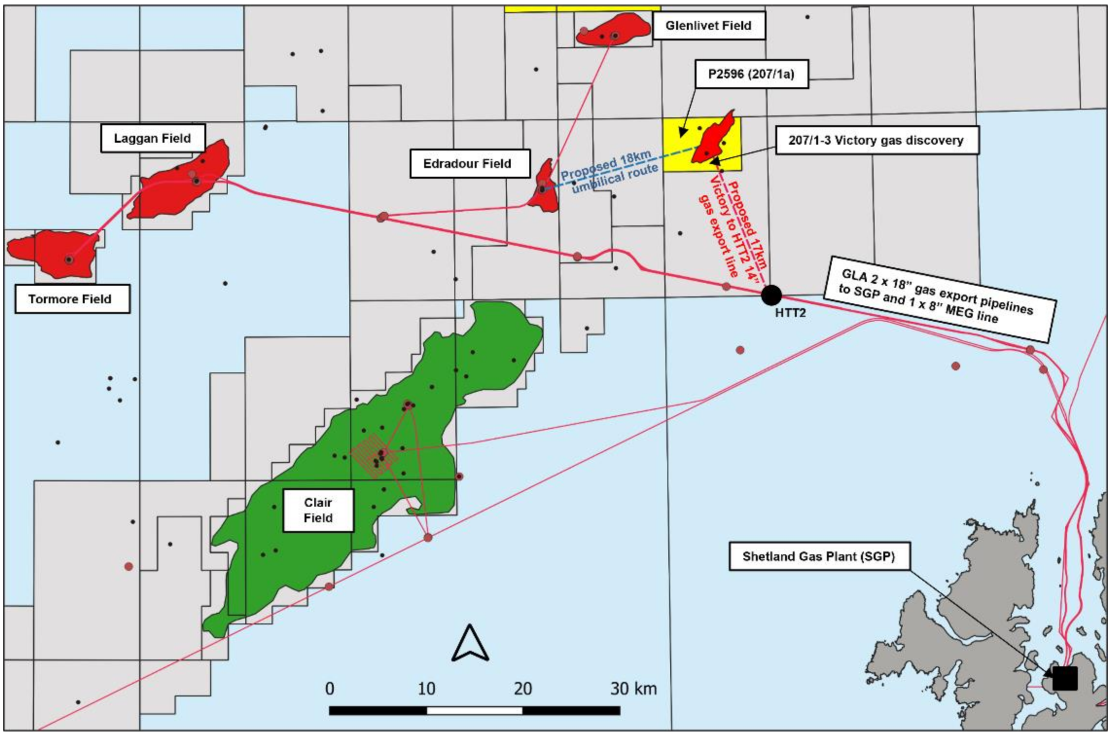
The GLA infrastructure was designed to accommodate future tie-backs and has spare control system capacity for satellite developments. As such, it is proposed that gas from the Victory field will be exported to the SGP for processing onshore via a new 14-inch export pipeline to one of the hot tap tees installed in the 18 inch Laggan - Tormore pipeline, located approximately 17 km to the south-east of the proposed Victory well. The pipeline will have a pigging skid at each end which will provide the valves and flanges to connect a temporary pig launcher and receiver. This will facilitate initial dewatering of the pipeline and subsequent intervention, if required.

The GLA control system will be expanded from the Edradour manifold via a new 18 km control umbilical which will carry electrical power, communications and hydraulics to the Victory well. In addition to the control system utilities, the umbilical will carry hydrate and corrosion inhibitor (MEG/corrosion inhibitor cocktail).

Minor modifications to the subsea control system and metering and allocation system will also be required at the SGP to tie-in the Victory development.

The design life of the Victory infrastructure (pipeline, umbilicals, wellhead and well) will be 15 – 20 years and therefore would be suitable for the life of a potential CCS project through the GLA infrastructure, anticipated for Victory to be around four years.

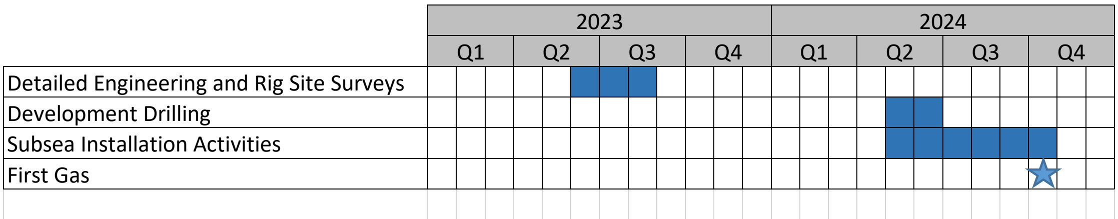
Figure 3.1: Victory and GLA Infrastructure



3.2 Project Schedule

The project schedule targets drilling the Victory well and installing the subsea infrastructure between May and October of 2024, with first gas in Q4 2024 (see Figure 3.2).

Figure 3.2: Victory Project Schedule



3.3 Drilling Operations

3.3.1 Nature of the Victory Reservoir

The Victory field was discovered by well 207/01- 3, drilled by Texaco in 1977, which encountered a thick, high quality sandstone reservoir. A Drill Stem Test (DST) was run within the sandstone interval which flowed lean, dry gas of up to 9.15 million standard cubic feet (MMSCF) per day, although the flow period was limited to 4 hours due to sand production. The Condensate to Gas Ratio (CGR) is expected to be very low, currently estimated at 1 bbl/MMSCF, with the specific gravity of the condensate estimated to be 0.816. Formation water production is not anticipated. The Victory field is expected to have a life of between 7 and 10 years depending on the reserves, the production rate and the life of the GLA infrastructure.

3.3.2 Drilling Strategy

The proposed surface location for the Victory production well is at 60° 58’ 10.163”N; 01° 54’ 31.955”W (ED50 UTM Zone 30N). The well will penetrate the Victory sandstone reservoir at ca. 1,182m TVDSS at a 55° inclination. The well design allows for a 90 m long inclined section through the reservoir with a 72m long gravel packed lower completion to negate potential sand production (the top and base 8 to 10 m of drilled reservoir will be cased off). The completed well will be cleaned up and produced through a temporary test facility on the drilling rig and a multi-rate flow test will be conducted to meet the required criteria for the GLA infrastructure.

3.3.3 Drilling Rig, Logistics and Support

A drilling rig has yet to be contracted for the project, however, it is expected that the Victory well will be drilled from a moored semi-submersible rig. For the purposes of the impact assessment, it is assumed that the rig will be moored in position via an eight-point mooring system, comprised of a combination of chain and wire. The estimated length of each mooring line will be approximately 1,100 m in length with approximately three quarters of this length laid on the seabed. The precise anchor mooring spread for the contracted semi-submersible rig will be defined by mooring analysis which will be undertaken prior to bringing the rig onto location and will take into account the water depth, currents, tides, prevailing wind conditions and any seabed features at the drilling locations. Two tugs and a separate anchor handling vessel (AHV) will be required to moor the rig in place.

A 500 m radius safety zone will be in place around the drilling rig for the duration of the drilling operations, anticipated to last up to 52 days. The consent to locate (CtL) permit application, to be submitted in advance of the rig arriving on location at the Victory Field, will detail the placement of the mooring lines and anchors. This will help to protect fishing vessels using bottom trawling gear from snagging and help ensure that the mooring lines and anchors are not compromised by fishing vessels and their associated gear.

An Emergency Rescue and Recovery vessel (ERRV) will be stationed in the vicinity of the rig during the drilling operations to assist in the event of an emergency. In addition, the rig be supported by a single supply vessel operating out of a supply base in Aberdeen or Peterhead, which is likely to visit the rig up to three times per week during the drilling operations.

Rig crews will be transferred to and from the drilling rig by helicopter. It is predicted that up to five scheduled flights will be made to the rig per week from Scatsta (Shetland) or Aberdeen for the duration of the drilling operations.

A summary of the vessel and helicopter requirements for the proposed drilling operations, along with typical fuel consumption rates are provided in Table 3.1.

Table 3.1: Vessel and Helicopter Overview for Victory Drilling Campaign

Vessel	Function	Duration in Field	Typical Fuel Consumption [1,2]	Total Fuel Consumption
Drilling Rig	Drill well	52 days	10 tonnes per day	520 tonnes
ERRV	Assist in the event of an emergency	52 days	8 tonnes per day	416 tonnes
2 x tugs and AHV	Anchor the drilling rig	6 days	15 tonnes per vessel per day	270 tonnes
Supply vessel	Logistic support and transportation of goods, tools, equipment	3 visits per week (22 trips)	20 tonnes per trip	440 tonnes
Helicopter	Transfer crew to and from drilling rig	5 return flights per week [3]	0.655 tonnes per hour	78 tonnes

[1] Typical fuel consumption rates for vessels based on data from IoP (2000).
[2] Based on speed of 262.6 km per hour (*Eurocopter, 2009*).
[3] Assumes five return flights to Aberdeen per week, located 420 km from the Victory location.

3.3.4 Well Design

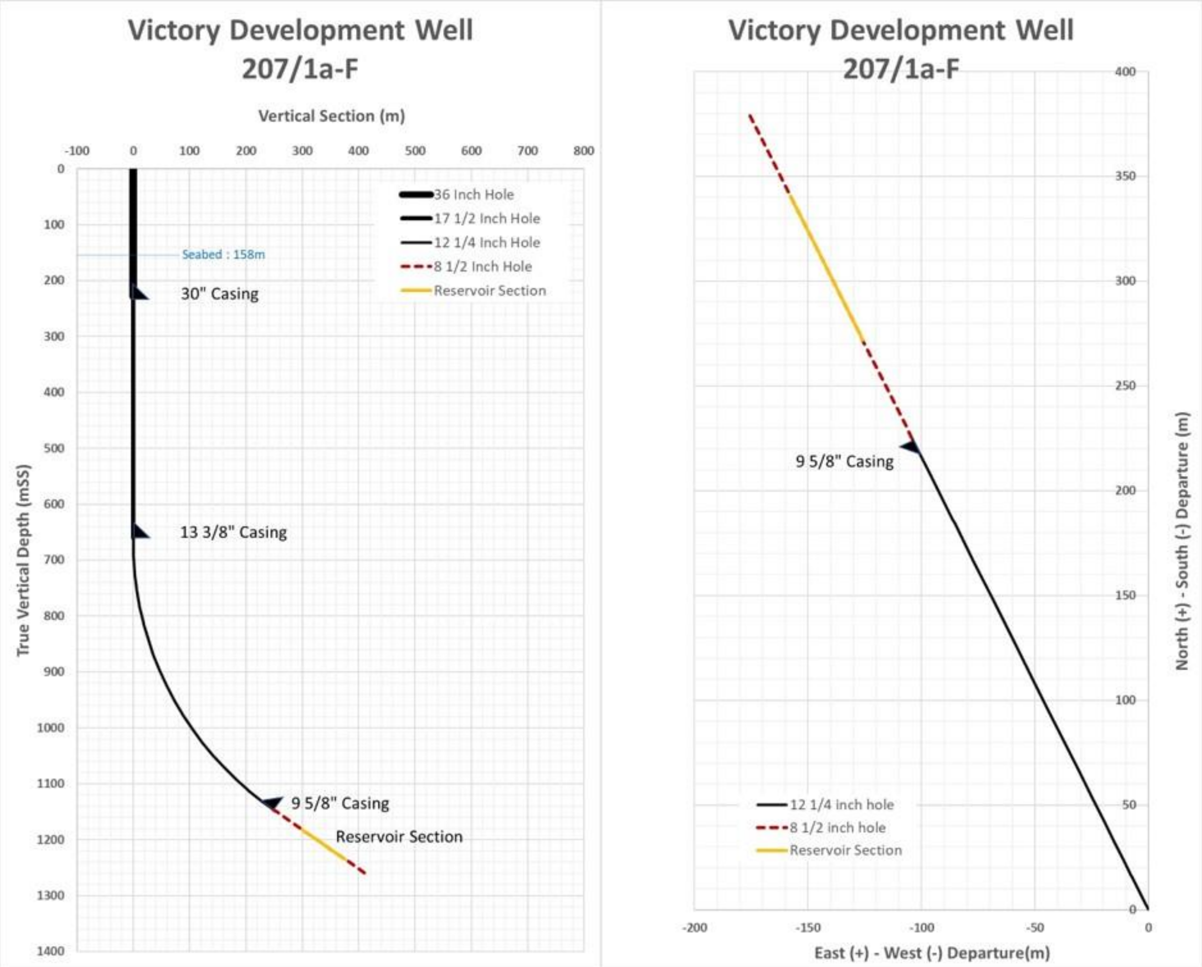
The proposed profile for the Victory well is detailed in Table 3.2 and illustrated in the well schematic provided in

Figure 3.3. A 36 inch-diameter top-hole section will be drilled, into which a 30 inch-diameter conductor pipe will be cemented. A 17½ inch section will then be drilled through the conductor and a 13⅜ inch-diameter steel casing installed and cemented into place. Following this, the wellhead and blowout preventer (BOP) will be installed, and a marine riser (a conduit from lengths of steel pipe) will connect the wellhead and BOP to the rig. The function of the BOP will be to prevent uncontrolled flow from the well to the surface during drilling by positively closing in the well in the event of an uncontrolled release from the reservoir into the well bore. A 12¼ inch section will then be drilled and a 9⅝ inch-diameter steel casing installed and cemented into place. Finally, the 8½ inch wellbore section will be drilled through the reservoir and a 7 inch liner will be installed, to provide a full mono-bore completion conduit.

Table 3.2: Indicative Profile of 207/1a- F well

Hole Diameter (inches)	Casing Diameter (inches)	Casing Type	Indicative Section Length (ft)	Indicative Section Length (m)
36	30	Conductor	230	70
17½	13⅜	Casing	1,418	432
12¼	9⅝	Casing	1,881	573
8½	7	Production liner	663	202
		Total	**4,192**	**1,277**

Figure 3.3: Victory Well Schematic



3.3.5 Mud System, Cuttings Disposal and Chemical Use

During the proposed drilling operations, a variety of chemicals will be used to facilitate the drilling processes and the safe completion of the well including drilling fluid (or mud) chemicals, cementing chemicals, well clean-up and completion chemicals. In addition, a number of chemicals will be used on the drilling rig for maintenance, such as detergents to wash the rig and lubricants for certain equipment and machinery. The BOP will also require chemicals for control and operation in the form of hydraulic fluids.

The use and discharge of the chemicals in offshore waters is regulated through The Offshore Chemicals Regulations (2002) (as amended). Prior to drilling the Victory well, Corallian will therefore seek consent from OPRED for the use and discharge of chemicals during the proposed drilling operations. A Drilling Operations Master Application Template (MAT) and associated Chemical Permit Subsidiary Application Template (SAT) will be submitted via the Portal Environmental Tracking System (PETS) on the UK Energy Portal. All chemicals proposed to be used will be selected based on their technical specifications and environmental performance. Chemicals with SUB warnings will be avoided where technically possible.

Drilling Mud

Drilling mud serves a number of functions including maintaining hydrostatic pressure within the wellbore, circulating rock fragments (termed 'cuttings') back to the drilling rig, preservation of the wellbore to facilitate casing / completion installation and cooling and lubrication of the drill bit.

For the top two hole sections (36" and 17½"), the Victory well will be drilled riserless with seawater and frequent bentonite "sweeps" passed down the well to clean out the hole. Cuttings from these top-hole sections will be discharged directly from the wellbore at the seabed.

For the deeper sections, a marine riser will be situated between the well and the drilling deck so that cuttings and drilling fluid are circulated back up to the rig for treatment. These sections will be drilled with a potassium chloride (KCl) glycol polymer water based mud (WBM). The drilling fluids and cuttings returned to the rig will pass through shale shakers, a device used to separate the cuttings from the drilling fluid by running it through a vibrating wire-cloth screen. The liquid phase of the mud passes through the screen, while the larger solids (i.e. the cuttings) are retained. The separated cuttings are then passed through a cleaning system and discharged to sea from the drilling rig just below the sea surface. The recovered WBM will be recycled downhole by the mud pump in a closed loop system, ensuring that the mud is continuously recycled during the drilling programme.

Cuttings Disposal

Table 3.3 details the proposed drilling mud requirements for the Victory well, the estimated quantity of cuttings which will be generated and the proposed disposal route.

Table 3.3: Estimated Quantity of Cuttings Generated from Drilling the Victory Well

Hole Diameter (inches)	Drilling Fluid	Volume of Drilling Fluid (m^3)	Estimated Weight of Cuttings (tonnes) Note 1	Cuttings Disposal Route
36	Seawater and bentonite sweeps	N/A	144	Discharged at the seabed
17½		N/A	209	
12¼	WBM	194	136	Discharged from the rig
8½	WBM	108	23	Discharged from the rig

Note 1: Includes 20% contingency

When drilling through the pay zone, in the event that oil is encountered, it is anticipated that the drill cuttings and muds may contain residues of reservoir hydrocarbons; this would be bound in the rock removed from the well by the drilling fluid (WBM). A small amount of reservoir hydrocarbons could therefore be discharged to sea with the cuttings after they have passed through the cuttings cleaning system, with the remainder transferred into the mud in negligible volumes (i.e. unmeasurable except through laboratory analysis).

Corallian will seek permission to discharge the potentially contaminated drill cuttings and muds via the submission of an Oil Discharge Permit SAT on the UK energy portal, as required under The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended).

The residue of hydrocarbons on cuttings is based on the calculated worst case, which is modelled to result in an oil-in-water discharge within permitted limits (i.e. $\leq$30 mg/l). It is estimated that the 8½ inch section of the well will penetrate the reservoir over a length of 110 m (a conservative estimate as the well design is based on a 90 m long inclined section through the reservoir), generating approximately 3.66 m^3 (11 tonnes) of cuttings, which could be contaminated with a total of 100 kg of hydrocarbons (Table 3.4). The hydrocarbon phase in the reservoir will be gas, as the well will be drilled updip from a gas well on the same structure. Some residual oil saturation is expected to be present, as the reservoir was previously charged with oil, and later displaced by gas. This irreducible oil saturation has been estimated to be between 3 and 10% of the pore volume. For the oil residue calculation, 10% saturation has been used.

Table 3.4: Residue of Hydrocarbons on Cuttings

Reservoir Length (m)	Hole Size (inch)	Volume of Cuttings (m^3)	Potential Pore Space for Hydrocarbons (m^3)	Liquid Hydrocarbons in Pore space (m^3)	Estimated Oil on Cuttings Discharge (kg)
110	8.5	3.66	0.76 (Note 1)	0.08 (Note 2)	100 (Note 3)

Note 1: Porosity (P10) is 28%.
Note 2: Residual oil saturation (P10) is 10%. Hydrocarbon net to gross is 100%.
Note 3: Residual oil specific gravity is ca. 0.9.

During the proposed drilling operations, a minimum of five samples will be taken from the shakers (at the point of discharge) and will be sent to a laboratory for analysis to ground truth the estimated amounts of reservoir hydrocarbons discharged.

Cement

Following completion of each well section, the steel casings will be cemented in place to form a seal between the casing and formation. The cement also acts as a pressure barrier between the casing and formation.

Most cement will remain in the annulus between the casing and the rock formation but some will be discharged at the seabed when cementing the 30 inch conductor as excess cement is pumped which provides visual confirmation that the cement job is complete. A remote operated vehicle (ROV) and chemical dye will be used to monitor cement returns during this phase to help ensure the volume of cement discharged to the seabed is kept at a minimum. Cement may also reach the seabed when cementing the 13 3/8” casing, but there are relatively small cement volumes in this section and accurately calculated estimates for excess cement will be made.

In addition, some cement and chemicals may be discharged as the cementing unit is cleaned between sections. The quantity discharged will be minimised by constant monitoring of the cementing operation and mixing of the cement as required. Typically only 10% of the total cement slurry will be discharged to the sea surface due to the clean-out of mixing pits following cementing operations, with up to 20% discharge for the cement spacer chemicals.

In total it is estimated that approximately 12 m^3 of cement may be discharged during the proposed drilling operations.

The use of ‘green cement’ will also be considered for Victory, if feasible. Green cement is manufactured at low temperature using the volcanic mineral ‘pozzolana’ as an additive, significantly reducing the cement’s CO_2 footprint. Recipes to be used in oil and gas wells are commercially available.

3.3.6 Well Testing and Clean-Up

Prior to production, the well will be cleaned up to remove any drilling fluids waste and debris remaining in the well to prevent damage to the pipeline. The wellbore will be cleaned-up with the in-situ drilling mud, then changed out to calcium chloride brine, the lower completion run, the lower completion gravel pack completed, then a further clean-up above the lower completion completed using the in-situ brine, before finally running the upper completion. During this process, approximately 800 bbls (127 m^3) of completion brine will be used and discharged.

Following clean-up, a main well flow test will be undertaken via the rig to obtain reservoir information and fluid samples. No chemicals will be needed to flow the well, but if the well does not flow naturally, nitrogen would be on standby to initiate flow artificially. There are currently envisaged to be three, six-hour flow periods during the well test. The amount of brine remaining in the tubing at the start of the well test programme is calculated to be ca. 178 bbls (28 m^3), which is included in the total 800bbls to be filtered / discharged as noted above. The vast majority of the brine in the tubing would be recovered, filtered and discharged during the first flow period, with very little to no further brine recovered during the second and third flow periods. The maximum amount of formation water expected to be produced during the well flow test, is 50 bbls (8 m^3). This would be separated from the gas, along with the brine during the first flow period.

All returned completion and well test fluids will be pumped to a filter unit on the rig prior to being discharged overboard. The retuned fluids have the potential to be contaminated with residual reservoir hydrocarbons and will only be discharged once the oil in water concentration is equal or below 30 mg/l after passing through a water treatment filtration package. In a worst case scenario, therefore, a total of around 4 kg of hydrocarbons might be discharged.

The likely sequence of events for clean-up and testing will be as follows:

- Open well and flow; initially the well will produce only calcium chloride brine which will be discharged to sea via the drilling rig;
- The water/hydrocarbon interface fluids will be captured and tested:
    - If oil in water concentration is equal to or below 30 milligrams per litre (mg/l) then the fluids will be discharged overboard in accordance with the Oil Discharge Permit; or
    - If oil in water concentration is above 30 mg/l they will be filtered until they are below 30 mg/l for overboard discharge;
- Clean-up will be monitored to capture data on the amount of water and suspended solids in the produced fluids (called the basic sediment and water specification);
- After the well has been cleaned up, the main well flow test will be conducted. The test duration will be across a total planned period of ten days, but only three flow periods, each up to six hours in duration, are planned with a steady increase in flow rates for each period. During this time up to 1,400 tonnes of equivalent hydrocarbon may be flared.

Following testing, the well will be closed in, ready for production. A fishing protection frame will be installed around the Xmas tree to ensure that it is protected and the snagging risk to trawlers is minimised (see Section 3.4.2).

3.3.7 Atmospheric Emissions Summary

Table 3.5 provides a worst-case estimate of the emissions to atmosphere arising from routine operations associated with the proposed Victory drilling operations.

Table 3.5: Estimated Atmospheric Emissions during Victory Drilling Operation

Source	Total Emissions (tonnes) [1]							
	CO_2	CO	NO_X	N_2O	SO_2	CH_4	VOC	CO_2e
Fuel Usage [2]	5,515	26.2	98.7	0.4	6.9	0.3	3.4	5,636
Flaring [3]	3,920	9.4	1.7	0.11	0.02	63	7	5,529
Total:	9,435	35.6	100.4	0.5	6.9	63.3	10.4	11,165

[1] Emissions factors from DECC (2008); GWP has been calculated using AR4 (IPCC, 2007).

[2] Total fuel usage from vessels estimated to be 1,724 tonnes (see Section 3.3.3).

[3] Assumes a total of 1,400 tonnes of equivalent hydrocarbon may be flared over three flow periods, each up to six hours in duration (see Section 3.3.6)

3.4 Victory Subsea Infrastructure

This section describes the installation of the Victory subsea infrastructure, including the wellhead, Xmas tree, pipeline, umbilical and associated tie-in arrangements. At the time of writing the ES, the pipeline route survey and subsequent detailed engineering studies have yet to be conducted, and are scheduled for summer 2023. Where relevant, both the base case and worst case options have therefore been presented below. In all cases, a worst case scenario has been assessed in the impact assessment chapters of this ES and all assumptions made have been clearly outlined. Any future changes to the proposed methodology will therefore aim to reduce the magnitude of impact on the marine environment.

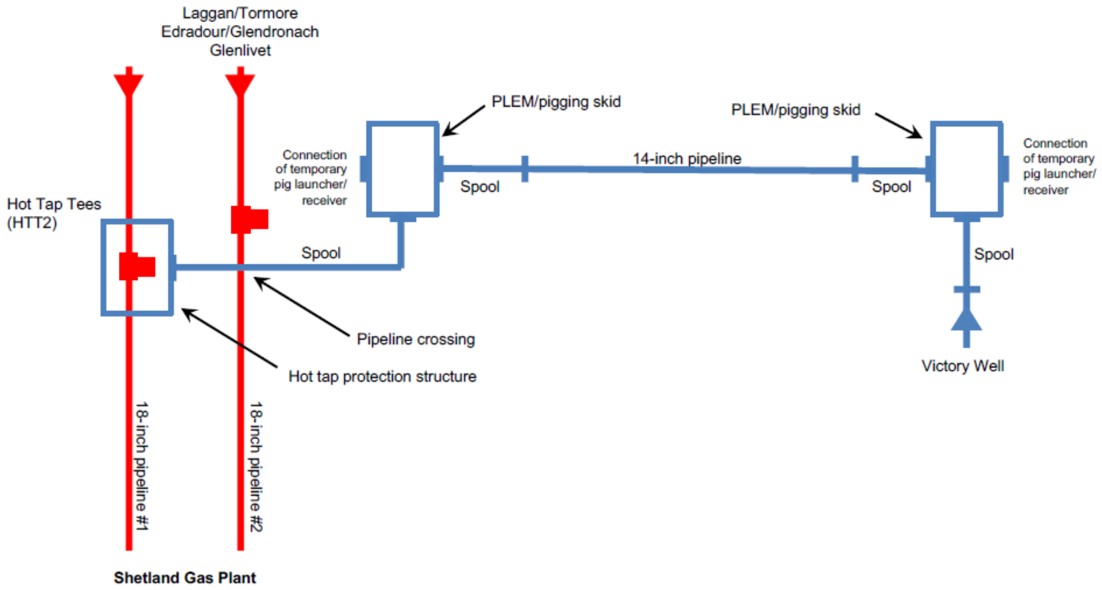
3.4.1 Overview of Subsea Production System

The main components of the subsea production system are as follows:

- The Victory well, with a fishing friendly protection structure installed over the wellhead and Xmas tree, connected to a new Pipeline End Manifold (PLEM) / Pigging Skid, located next to the well location, by rigid tie-in spools (30 m in length);
- Production fluids from the Victory PLEM / Pigging Skid will be transported through a new 16.2 km, 14 inch carbon steel production pipeline to a new PLEM / Tie-in Structure located near to one of the hot tap tees (HTT) on the 18 inch Laggan- Tormore production pipelines. Rigid tie-in spools (40 m in length at each end) will connect the Victory PLEM / Pigging Skid and the Victory Tie-in Structure to the Victory production pipeline.
- One new Protection Structure will be installed at the selected HTT2 tie-in point. A flexible line (220 m in length) will connect the protection structure to the Victory PLEM / Tie-in Structure.
- Control of the Victory facilities will be provided by a new 18 km umbilical from the Edradour manifold to the Victory Pigging Skid, with jumpers (30 m in length) from the Pigging Skid to the Victory well. At the Edradour manifold a new tie-in structure is required, which will be connected to the manifold via a rigid L shaped multi-bore spool.

A schematic of the tie-in arrangements at Victory and HTT2 is provided in Figure 3.4. The 18-inch Laggan- Tormore production pipelines are designated flowline 1 (FL1) and 2 (FL2), FL1 being on the south side of FL2. The hot tap tees at this location are therefore termed HTT1-2 and HTT2-2. The tie-in to HTT1-2 results in a 220 m long flexible jumper compared with 170 m long for HTT2-2 and a crossing of the 18-inch FL2. However, the preferred hot tap is HTT1-2 on FL1 because it is in-line with the design intent of the Edradour PLEM and tie-in to HTT2-2 would result in the flexible between the Edradour PLEM and FL1 being a pressurised dead leg.

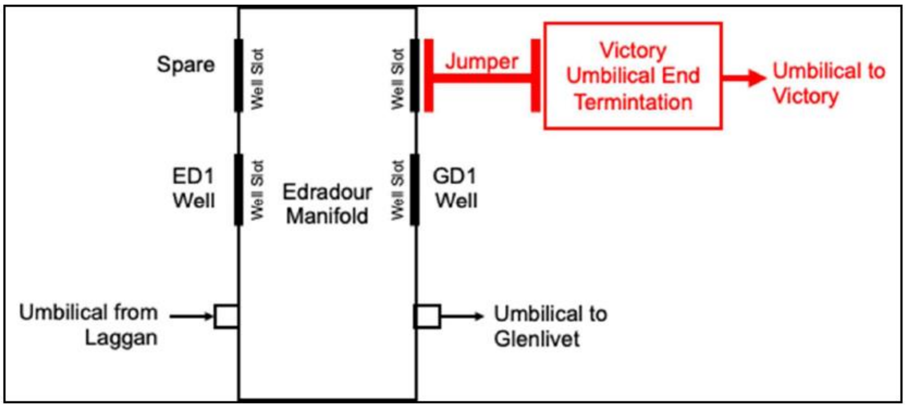
Figure 3.4: Victory Pipeline Tie-in Infrastructure Schematic



Corallian proposes to apply for a 500 m safety zone to be in place around the Victory well, which will also encompass the Victory Pigging Skid. There is no existing 500 m safety zone at the HTT tie-in point, therefore the HTT Protection Structure and Victory Tie-in Structure will be overtrawlable.

At the Edradour manifold, there is currently no spare direct tie-in for the connection of the Victory umbilical. The connection of the umbilical will therefore be taken from one of the spare well slot tie-ins as shown in Figure 3.5.

Figure 3.5: Connection of Victory at the Edradour Manifold

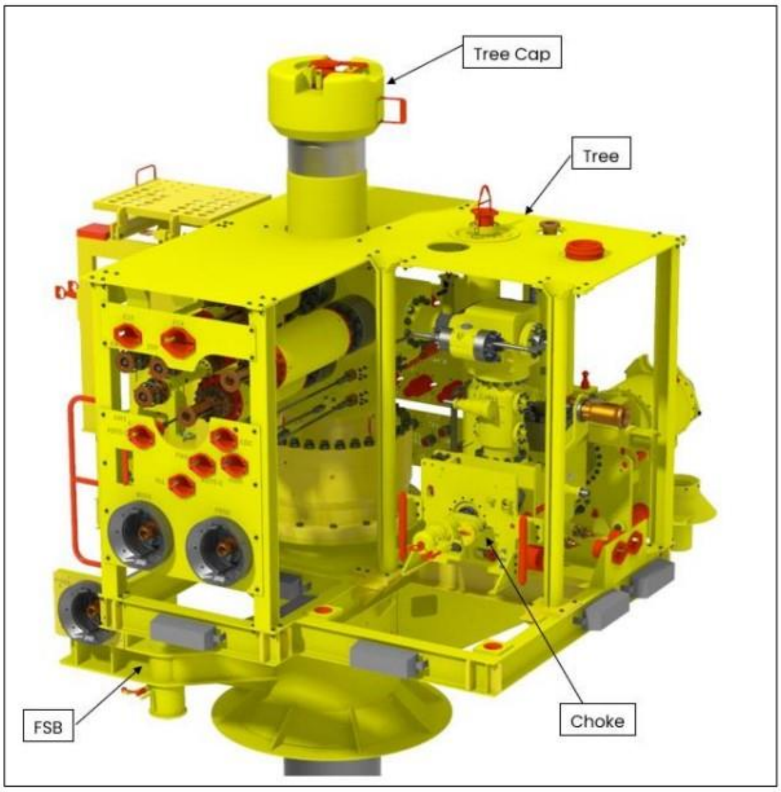


3.4.2 Wellhead and Xmas Tree

Upon well completion, a subsea xmas tree designed to control flow will be installed on top of the wellhead by the drilling rig. The subsea tree is the main barrier between the reservoir and the environment and also provides a mechanism for flow control and well entry. The well will have a sub-surface safety valve installed which is an isolation device that is hydraulically operated, and fail-safe closed. The subsea tree will be controlled remotely from the SGP.

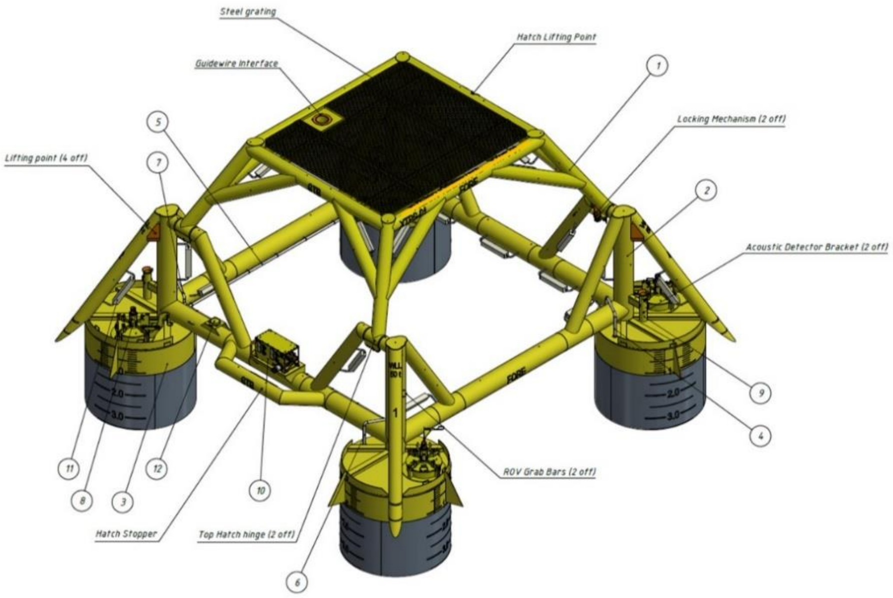
A vertical xmas tree (Figure 3.6) is preferred for Victory, to provide a simple and reliable design and controls package, and as no workovers are planned during the producing life of the well.

Figure 3.6: Indicative Vertical Xmas Tree System



The wellhead and xmas tree will be enclosed within an industry standard fishing friendly wellhead protection structure (WHPS), which is designed to ensure the tree and its connections are not damaged by dropped objects or impacts and snagging loads associated with fishing gear (Figure 3.7). The overall dimensions are estimated to be approximately 18 m (L) x 18 m (W) x 11 m (H).

Figure 3.7: Example of a Wellhead Protection Structure



Installation of the WHPS is expected to be done by a multi-service vessel (MSV) or dive support vessel (DSV). The foundation design is yet to be confirmed and may comprise suction cans or hammered piles. The impact from hammer piling has been assessed in the ES as it is considered worst case from an underwater noise perspective. It is assumed that the WHPS would be held in place by four tubular piles, one at each corner, each with a diameter of 0.914 m (36 inch) and length of up to 18m. The piles would be secured into the seabed using a maximum hammer blow energy of 50 kJ, with a blow rate of 65 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to one hour.

3.4.3 PLEM / Pigging Skid and Tie-in / Protection Structures

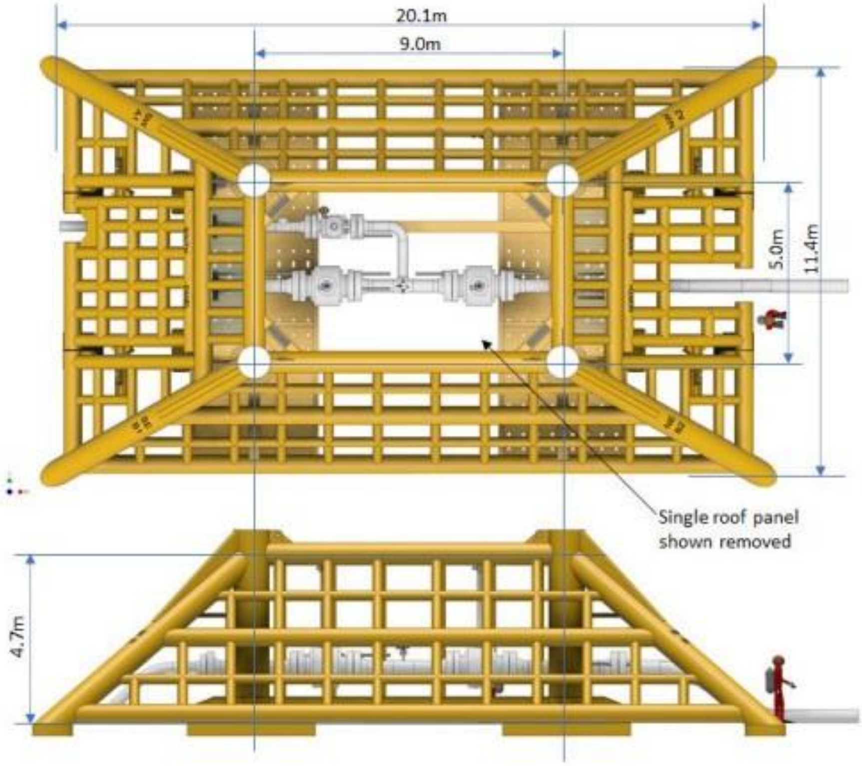
Victory PLEM / Pigging Skid

The Victory PLEM / Pigging Skid will provide connections for installation of temporary subsea pig launchers / receivers and will include piping to distribute MEG and service line fluids to the Victory well, as well as providing production tie-ins for future wells. The control umbilical will terminate at an Umbilical End Termination (UET) within the structure. Controls, communications and chemicals will be distributed from the UET to the Victory well.

The PLEM / Pigging Skid will be an overtrawlable structure and, based on preliminary engineering, it may consist of three components; a base structure, a piping module and a removable roof structure. The overall dimensions are estimated to be approximately 20 m (L) x 11 m (W) x 5 m (H).

Installation of the Pigging Skid is expected to be done by a MSV or a DSV. The foundation design is yet to be confirmed and may comprise suction anchors or hammered piles. The impact from hammer piling has been assessed in the ES as it is considered worst case from an underwater noise perspective. It is assumed that the subsea structure would be held in place by four tubular piles, one at each corner, each with a diameter of 0.914 m (36 inch) and length of up to 18m. The piles would be secured into the seabed using a maximum hammer blow energy of 50 kJ, with a blow rate of 65 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to one hour.

Figure 3.8: Victory Pigging Skid Layout and Protection Structure



Victory PLEM / Tie-in Structure

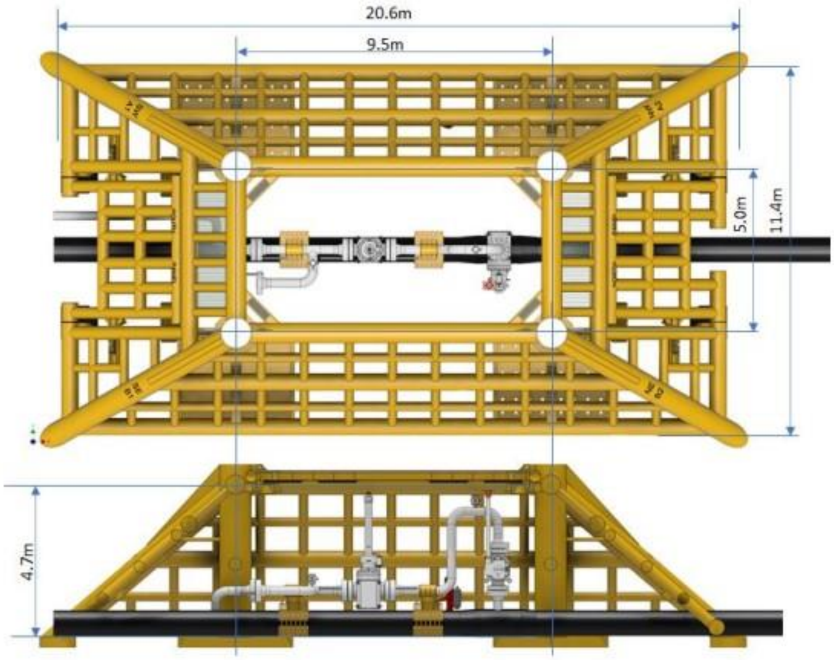
The purpose of the Victory PLEM / Tie-in Structure at HTT2 is to terminate the Victory production pipeline and provide pipework and valves to route the line to the equivalent Laggan-Tormore pipeline. It will also provide connections for installation of temporary subsea pig launchers / receivers, and will provide a future tie-ins for production to replace that taken up at HTT2 by the Victory development.

The PLEM / Tie-in Structure will be overtrawlable and is estimated to have overall dimensions of approximately 20 m (L) x 11 m (W) x 5 m (H) (Figure 3.8). It is expected to be installed with the use of a MSV or DSV. Further engineering studies are necessary to develop the foundation design; therefore the impact from hammer piling has been assessed in this ES as it is considered worst case from an underwater noise perspective. It is assumed that the subsea structure would be held in place by four tubular piles, one at each corner, each with a diameter of 0.914 m (36 inch) and length of up to 18m. The piles would be secured into the seabed using a maximum hammer blow energy of 50 kJ, with a blow rate of 65 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to one hour.

HTT2 Protection Structure

The purpose of the protection structure is to protect the pipework and valves at the hot tap. The structure will be overtrawlable and is estimated to have an overall dimension of approximately 20 m (L) x 11 m (W) x 5 m (H) (Figure 3.9). It is expected to be installed with the use of a MSV or DSV. Further engineering studies are necessary to develop the foundation design; therefore the impact from hammer piling has been assessed in this ES as it is considered worst case from an underwater noise perspective. It is assumed that the subsea structure would be held in place by four tubular piles, one at each corner, each with a diameter of 0.914 m (36 inch) and length of up to 18m. The piles would be secured into the seabed using a maximum hammer blow energy of 50 kJ, with a blow rate of 65 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to one hour.

Figure 3.9: HTT2 Tie-In Layout and Protection Structure

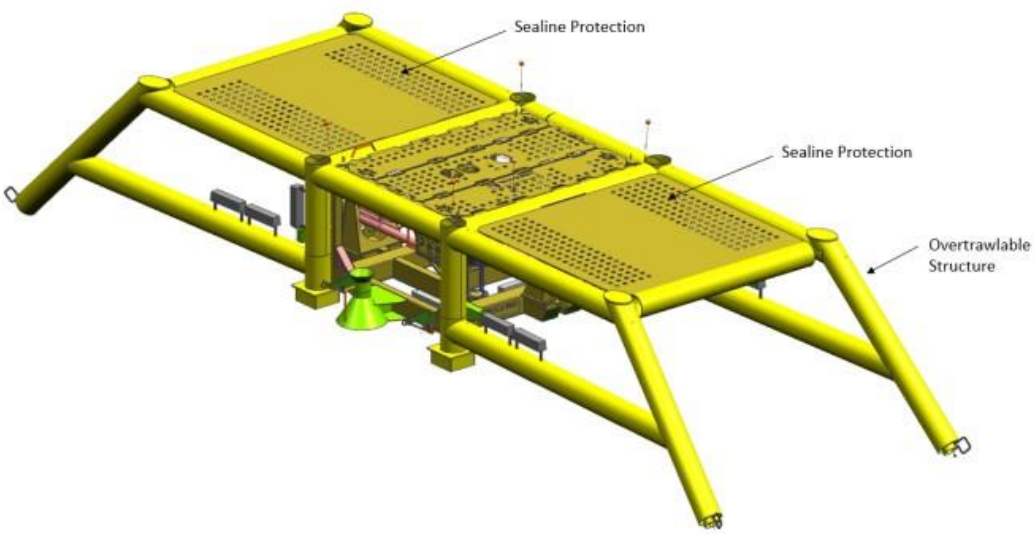


Victory Umbilical Tie-in Structure

At the Edradour manifold a new tie-in structure is required to provide a like-for-like replacement universal connector multi-bore hub for a future connection and a universal connector umbilical hub for the Victory umbilical. The tie-in structure (Figure 3.10) will be a modular, overtrawlable design with the overall structure dimensions assumed to be approximately 20 m (L) x 11 m (W) x 5 m (H).

The foundation design is yet to be confirmed, but is likely to be suction piled, the same as the existing Edradour manifold. However, the impact from hammer piling has been assessed in the ES as it is considered worst case from an underwater noise perspective. It is assumed that the subsea structure would be held in place by four tubular piles, one at each corner, each with a diameter of 0.914 m (36 inch) and length of up to 18m. The piles would be secured into the seabed using a maximum hammer blow energy of 50 kJ, with a blow rate of 65 blows per minute. It is expected that the hammering operations for each pile will be ongoing for up to one hour.

Figure 3.10: Victory Umbilical Tie-in Structure at Edradour



3.4.4 Production Pipeline and Umbilical

Pipeline Design

Production from Victory will flow to one of the hot tap tees on the Laggan- Tormore production pipelines via a new 16.2km long 14-inch carbon steel pipeline which will be connected to the Victory PLEM / Pigging Skid at one end and Victory PLEM / Tie-in Structure at the other (see Table 3.6).

Table 3.6: Victory Production Pipeline

Pipeline	Service	Length	Diameter	Design Pressure	Materials	External Coating
Victory Production Pipeline	Multi-phase production fluids (gas, condensate, water) plus MEG	16.2 km	14 inch	380 barg	Carbon Steel	3LPP[1]

[1] 3-Layer Polypropylene is a multilayer coating composed of three functional components; a high performance Fusion Bonded Epoxy primer, followed by a copolymer adhesive, and an outer layer of polypropylene.

The pipeline will be protected against corrosion by the continuous injection of corrosion inhibitor, supplied as a cocktail with the hydrate inhibitor (MEG) at the subsea xmas tree. The corrosion inhibitor cocktail is already in use in the GLA system. The use of hydrate inhibitor is standard practise in the UKCS and MEG is already in use in the GLA system, although Victory is less prone to hydrates than the other GLA fields.

Umbilical Design

It is proposed that the GLA control system will be expanded from the Edradour manifold via a new 18 km thermoplastic control umbilical to the Victory well.

The Victory umbilical will carry the following utility supplies:

- Dual high pressure (7,500 psig) hydraulic supplies for the downhole safety valves / surface-controlled subsurface safety valves;
- Dual low pressure (3,000 psig) hydraulic supplies for the xmas tree valves;
- Dual chemical supplies (c. 7,500 psig) for MEG/corrosion inhibitor cocktail via a 1.25” (31.8mm) central core;
- Dual electrical power;
- Fibre optics for communications.

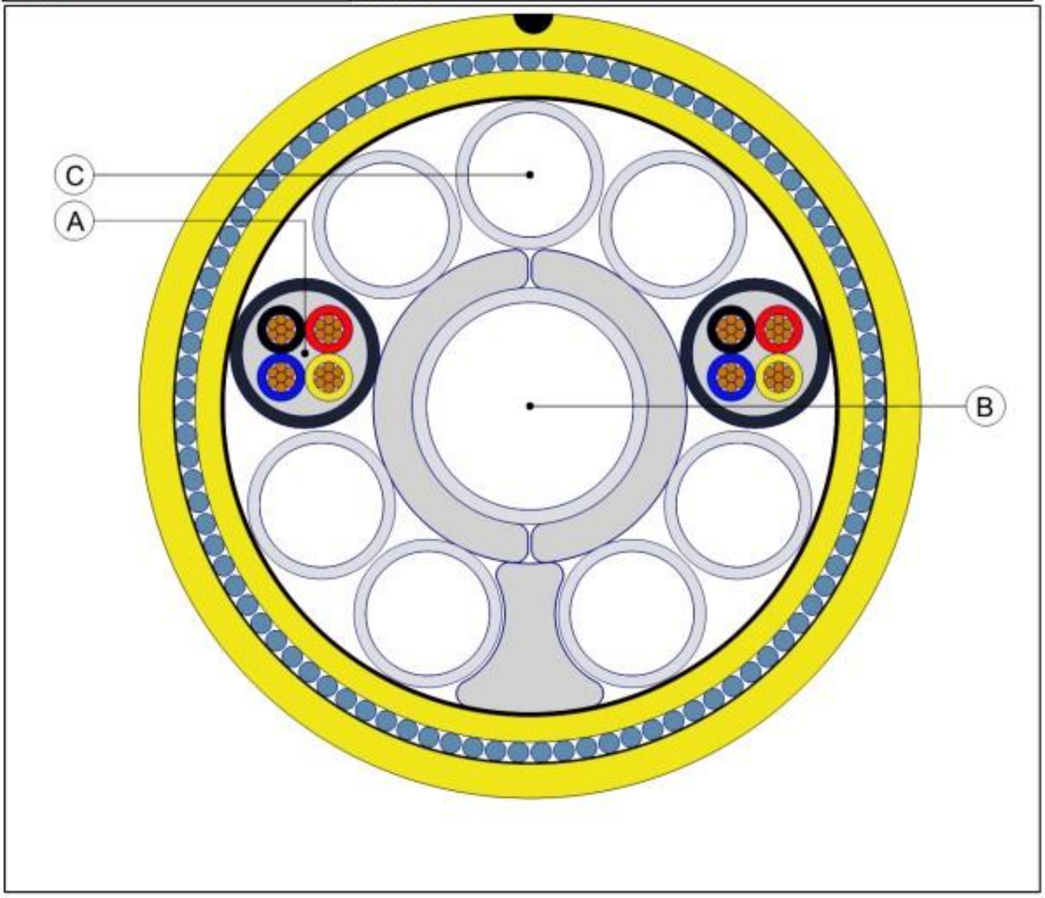
It will be terminated at each end with a subsea umbilical termination as illustrated in Figure 3.5.

The Victory umbilical has been designed using the same philosophy as the previously installed Glenlivet and Edradour umbilicals, although it will be of a smaller diameter, 120mm (ca. 4.7 inch) outside diameter (OD) versus 133 – 135mm OD. The umbilical cross-section (Figure 3.11) has been designed for seabed stability and requires a single layer of armour to increase the mass due to the anticipated method of installation.

Figure 3.11: Victory Umbilical Cross-Section

Cross Section (V4.10)

TechnipFMC	DU300378-01-001 Rev 1 : Static Section GENESIS VICTORY TIE-IN UMBILICAL STUDY VICTORY



Key	Qty	Description
A	2	16mm² Quad Ø22.9mm
B	1	31.8mm NB Super Duplex Tubes, 2.2mm Nominal WT, 517 BAR WP
C	7	19.05mm NB Super Duplex Tubes, 1.82mm Nominal WT, 689 BAR WP
	-	3.9mm HDPE INNER SHEATH
	-	Ø3.15mm STEEL ARMOUR WIRES
	-	5.2mm HDPE OUTER SHEATH

Theoretical Characteristics (Metric)			
Outside Diameter	120.2mm	Mass in Air (hoses/tubes water filled)	24.1 kg/m
Diameter to Weight Ratio	8.6mm.kg-1.m	In-Service Weight (in sea water)	137.1 N/m
Min. Bending Radius (for storage)	1.54m	Max. Installation Load (in a straight Line)	279.2kN
Length	18000m	Bending Stiffness at 20°C	19770N.m²

Installation Operations

The original assumption for the installation of the pipeline and umbilical was that the lines would be trenched and buried. However, based on experience gained during design and installation of the GLA pipelines in this area, this will not be possible due to the presence of seabed and buried boulders (refer to Section 2.2.3).

The survey data collected to date along the proposed pipeline route observed a largely sandy seabed in the north with areas of higher reflectivity in the south, interpreted to be areas of sand, sand with gravel, cobbles and occasional boulders and isolated megaripples and ripples. The umbilical route also displayed a sandy seabed with isolated megaripples and bands of megarippled sands with gravel, cobbles and boulders present along most of the corridor in varying densities.

A total of 56 sonar contacts/boulders were identified along the pipeline route, with 1,203 identified along the umbilical route to Edradour (see Figures 2.2 and 2.3 in Section 2.2.3). Ploughing and backfilling tools are capable of accommodating boulders or other isolated obstructions up to 0.5 m in dimension. Analysis of the survey data indicates that of the contacts which have been given heights, there are six within 20 m of the pipeline route and eight within 20 m of the umbilical, which have a height greater than 0.5 m.

Large meggaripples or sand waves (approximately 15 to < 50 m) were also observed at the Victory location and along the initial part of the pipeline route (see Figure 2.4 in Section 2.2.3). As such, post-lay ploughs are unlikely to be able to be used in these areas.

Given the above, the following two options are therefore being considered for installation of the Victory pipeline and umbilical:

- Base case (seabed lay) option: Very narrow pre-cleared corridors will be created (one for the pipeline and one for the umbilical corridors) from which any residual boulders greater than 0.5 m will be removed. The pipeline and umbilical will be laid on the seabed within these corridors, following which they would be covered with rock to achieve stability and protection.
- Worst case (rock carpet) option: Rock protection will be used both underneath and on top of the pipeline and umbilical. A rock dump vessel would be used to install a rock carpet on the seabed, upon which the lines would be placed using a pipelay vessel. Following pipelay, further rock would be placed on top of the pipeline and umbilical for protection and stabilisation purposes. This option is considered to be worst case from an environmental impact perspective due to the larger seabed footprint, greater quantity of rock protection material required and higher installation vessel requirements.

Based on the survey data collected to date, the base case option is likely to be achievable for both the Victory pipeline and umbilical. Corallian understands that this method was also used by TotalEnergies for the Edradour and Glenlivet developments. However, the potential exists for additional boulders to be present below the seabed within the footprint of the Victory development, which may make the base case option unfeasible. The presence of subsea boulders within the route corridors will need to be identified with the use of a sub-bottom profiler during the pipeline route surveys. The stability of the sand waves is also of concern if further survey work identifies that these are moving as it may then be preferable to install the pipeline below the trough of the wave. The final installation solution will therefore only be determined once the pipeline route survey and subsequent detailed engineering studies have been conducted. For the purposes of the ES, further details on the installation methodology associated with both the base case and worst case options have been provided below, but the assessment of impacts to the environment is based on the worst case option.

<u>Victory Rock Carpet Option</u>

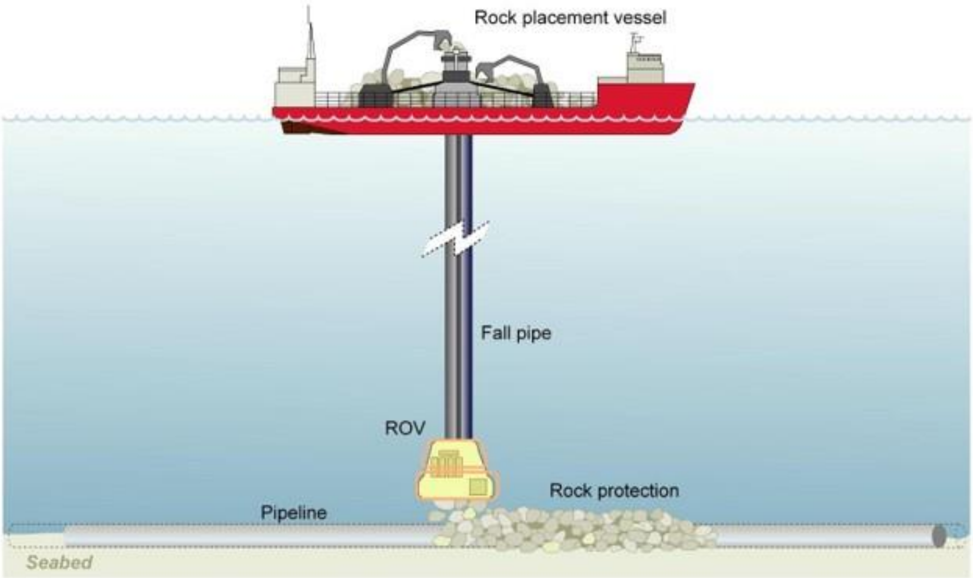
For the rock carpet option, prior to the pipeline and umbilical lay, a rock placement vessel would deposit rock on the seabed along the pipeline and umbilical route corridors via a fall pipe, which will terminate few metres above the seabed (Figure 3.12). The position of the fall pipe in relation to the seabed would be controlled by ROV. Based on previous experience West of Shetland, the rock material used is likely to have a diameter of up to 12.5 cm. It will have been washed prior to use to ensure minimal entrained fines.

Once the rock carpet has been deposited, the production pipeline between the Victory Pigging Skid and the Victory Tie-in Structure would be installed, most likely via S-lay using a reel-lay vessel. This method involves the pipeline being welded onshore and spooled onto a pipe reel in one continuous length which, once offshore at the installation site, can be unspooled, straightened and released overboard as the vessel moves along the prepared route. It is assumed that the umbilical would be laid by a separate umbilical lay vessel or by a DSV.

The initiation of the pipeline and umbilical will require the installation of a temporary initiation anchor (either a conventional anchor or dead man anchor) and the use of an initiation wire, which will connect between the anchor and the end of the pipeline/umbilical. The initiation wire for both the pipeline and umbilical is expected to be no longer than 500 m in length. Following the installation of the pipeline/umbilical the anchor and wire will be recovered.

As-laid surveys would be performed astern of the pipelay vessels to confirm the pipeline and umbilical have been installed in the correct position. Following installation, further rock placement would be undertaken to cover the pipeline and umbilical for protection and upheaval buckling mitigation.

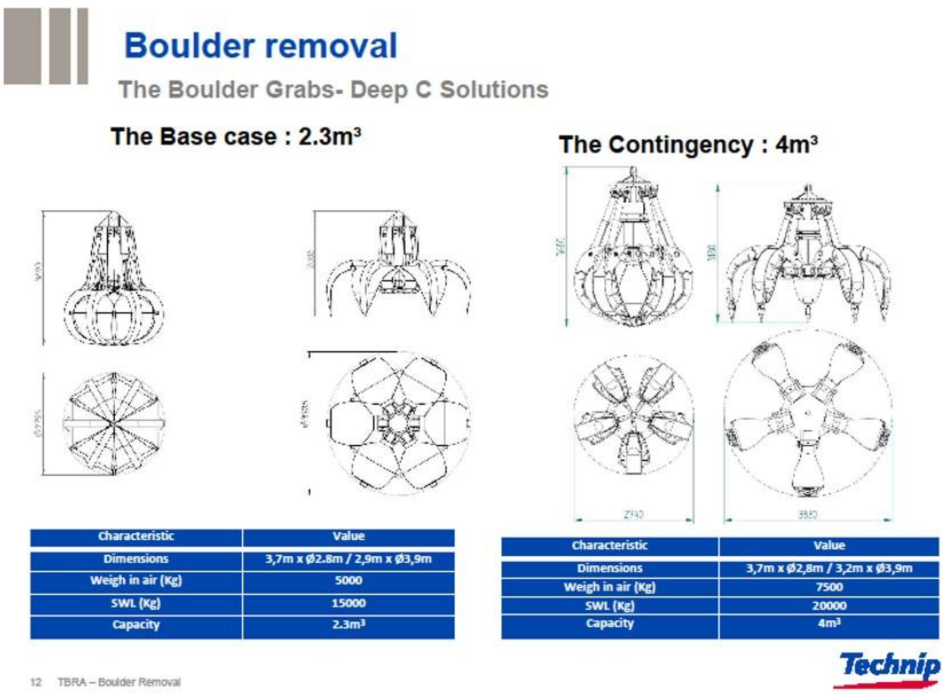
Figure 3.12: Rock Placement Vessel



Victory Seabed Lay Option

For the seabed lay option, any large boulders will first be identified and removed from the pipeline and umbilical lay corridors with the use of a boulder grabber (see Figure 3.13). Where boulder presence is such that the route cannot be cleared sufficiently, that length of the route will be subject to pre-lay rock carpeting, as detailed above. For the boulders moved outside the lay corridors and left on the seabed, the as-left position was recorded.

Figure 3.13: Boulder Grabber



Experience from the Edradour and Glenlivet developments indicates that all boulders greater than 0.5 m would need to be removed from a 20 m wide corridor centred on the pipeline and from a 10 m wide corridor centred on the umbilical, with the disposal corridor (assumed to be 5 m wide) situated approximately 3 m away from the edge of cleared corridor.

Once the route is cleared of boulders (and rock carpet installed as necessary), the production pipeline and umbilical would be installed and protected as described above.

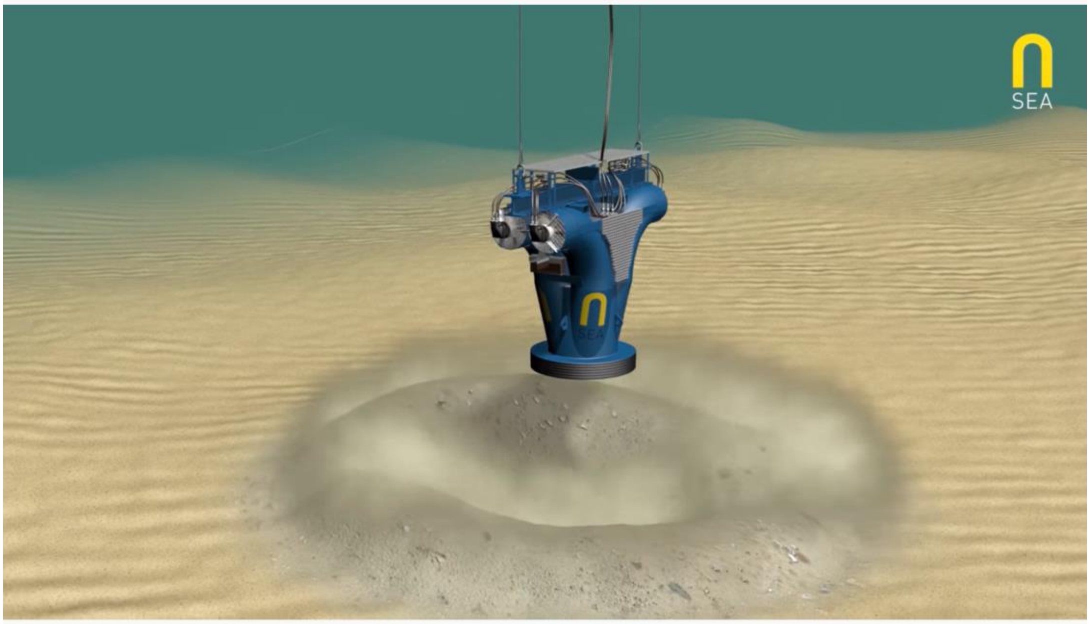
Optional Dredging of Sand Waves

Prior to the installation of the production pipeline, there may also be a requirement to dredge the top of the sand wave crests along the initial 2.5 km section of the route from the Victory well location. It is unknown whether these mega ripples are mobile. Although there are no apparent surface boulders along this section of the pipeline route (refer to Section 2.2.3), post-lay ploughs are unlikely to be able to be used in this area due to the ploughing limits associated with slopes.

The environmental survey data shows the mega ripples to have an amplitude (trough to crest) of up to 1.5 m. To minimise the amount of rock cover required, it is proposed to lay the pipeline in the trough of the mega ripples where possible and then use a mass flow excavator (Figure 3.14) to create a swathe approximately 5 m wide where it is necessary to cross a mega ripple. It is assumed that rock would then be placement along this length of the pipeline for protection and upheaval buckling mitigation.

Note, there are no apparent surface boulders in the sand wave area, but this will be confirmed with a sub-bottom profiler during the detailed engineering surveys. An optimum route through the sand wave area will be investigated and dredging will be used, if applicable, to reduce the amount of rock dumping.

Figure 3.14: Example Mass Flow Excavator Tool

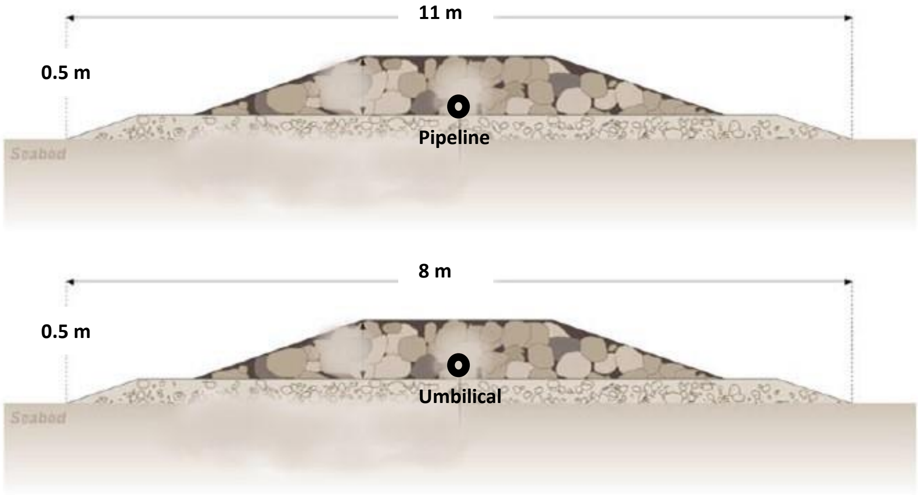


Rock Quantity Estimate

An estimate of the quantity of rock that may need to be deposited pre- and post-lay is provided in Table 3.7. It is assumed that a carpet berm height of 0.5 m will be required for both the Victory production pipeline and the umbilical to Edradour, based on the reported boulder sizes in the area. In a worst case scenario, assuming that both the pipeline and umbilical are installed via the rocket carpet method (with both pre- and post-lay rock required) up to 453,212 tonnes of rock will be needed. A breakdown of how this total has been calculated is provided in Table 3.8. A 20% contingency (90,642 tonnes) has then been added to this total, to allow for the fact that data from the detailed engineering surveys is still pending, therefore in total up to 543,854 tonnes of rock may need to be deposited to install the pipeline and umbilical.

The total area of seabed impacted in this scenario is estimated to be around 322,200 m^2 (0.3 km^2), which assumes a base rock berm width of 11 m for the pipeline and 8 m for the umbilical (Figure 3.15). This includes any disturbance related to the use of a mass flow excavator when crossing the sandwaves, but excludes seabed disturbance relating to the disposal corridor.

Figure 3.15: Rock Berm Profiles (Pipeline and Umbilical



The disposal corridor is assumed to be 5 m wide and would be located approximately 3 m away from the edge of the cleared corridor. Based on the survey data collected to date, it is estimated that 3 boulders may need to be cleared from the pipeline corridor and 18 boulders may need to be cleared from the umbilical corridor. Assuming that each boulder will disturb an area of ca. 1 m^2 when relocated, the area disturbed within the disposal corridor will be in the region of 21 m^2.

Note, as part of forthcoming detailed engineering studies the option to use a weighted pipeline will be investigated, which may reduce the worst case quantity of rock to be deposited, as detailed in Table 3.7.

Table 3.7: Rock Quantity Estimate

Installation Method	Pipeline			Umbilical Estimate		
	Rock (tonnes)	Berm Base Width (m)	Seabed Footprint (m^2)	Rock (tonnes)	Berm Base Width (m)	Seabed Footprint (m^2)
Pre-lay Carpet	158,260	11	178,200 [1]	120,283	8	144,000 [1]
Post-lay Cover	114,220	8	129,600	60,450	5	90,000
Sub-Total:	**272,480**	**-**	**-**	**180,732**	**-**	**-**
Contingency [2]:	54,496	-	-	36,146	-	-
Total:	**326,976**	**-**	**-**	**216,878**	**-**	**-**

[1] Excludes disturbance relating to the disposal corridor.
[2] As a worst case, a contingency of 20% has been added to the sub-total to account for the fact that data from the detailed engineering surveys is still pending.

Table 3.8: Justification of Rock Quantity Calculation

Line Properties	Unit	Pipeline	Umbilical
Line OD	m	0.3606	0.1
Line Length	m	16180	17973
Rock Properties			
Over Dump	m	0.1	0.1
Post Lay Berm Top Width	m	1.5	1
Side Slope	1:	3	3
Wastage	%	10%	10%
Rock Bulk Density	T/m3	1.56	1.56
Carpet Properties			
Carpet Height	m	0.5	0.5
Carpet Base Width	m	11	8
Carpet Top Width	M	8	5
Rock Volume	m^3/m	6.27	4.29
Total Volume	m^3	101,449	77,104
Tonnage	**T**	**158,260**	**120,283**
Post Lay Dump			
Base Height	M	0.5	0.5
Route Percentage	%	90%	100%
Base Width	M	6.6636	4.6
Rock Volume	m^3/m	4.31307479	2.156
Local Height	m	0.75	0.5
Route Percentage	%	10%	0%
Local Width	m	8.1636	4.6
Rock Volume	m^3/m	6.43431479	2.156
Total Volume	m^3	73,218	38,750
Tonnage	**T**	**114,220**	**60,450**

<u>Temporary Laydown Area</u>

Temporary laydown areas will be required at the Victory well and the hot tap tee. These will be used during the diving works for the deployment of diver tools (typically deployed in baskets with a footprint of approximately 2m x 2m) and short-term storage of tie-in pipe spools. The dimensions of each temporary laydown area will not exceed 100 m x 100 m and they will be located within the surveyed area. Their use will be minimised and all items will be recovered from the seabed following the completion of the installation of the subsea infrastructure.

3.4.5 Tie-in Arrangements

Table 3.9 summarises the tie-in arrangements for the Victory development.

The Victory well will be connected to the Victory PLEM / Pigging Skid with tie-in spools and control jumpers. These will be protected by concrete mattresses.

The Victory production pipeline will be connected to the Victory PLEM / Tie-in Structure and Victory PLEM / Pigging Skid with tie-in spools. These will be protected by concrete mattresses.

The tie-in to the Laggan Tormore production flowlines will be achieved by installing valves on the hot tap tee and then making the hot tap using proprietary hot tap equipment. A new overtrawlable protection structure will then be installed to protect the pipework and valves at the hot tap (see Section 3.4.3). In order to undertake this work the existing protection (rock berm) over the HTT2 structure will need to be removed. A mass flow excavator will likely be used to relocate the existing rock cover, which will displace the rock adjacent to the HTT2 structure out to a distance of up to 10 m. The hot-tap will then be installed and a flexible line, 220 m in length, installed between HTT2 and the Victory PLEM / Tie-in Structure. The flexible line will cross the following existing lines: the main GLA umbilical (trenched and buried), the 8” MEG / service line (rock dumped) and flowline 2 (FL2) (exposed at the seabed), and will be protected by rock (Figure 3.16). Detailed engineering for the pipeline crossings is not yet available; however it is assumed that mattresses will be used over the rock berms, with additional rock placed over the mattresses to prevent a snagging hazard. TotalEnergies will be responsible for all work at the hot tap tee, including installation of the flexible line to the Victory PLEM / Tie-in Structure.

The selected branch connection on the Edradour manifold for the Victory tie-in is in the north east corner hub, as shown in Figure 3.17. The umbilical tie-in structure will be linked to the Edradour manifold via a multi-bore rigid spool with universal connections. In order to access the Edradour manifold the existing protection (rock berm) over the Glass Fibre Reinforced Polymer (GRP) cover will need to be removed. As above, a mass flow excavator will likely be used to do this, which will relocate the rock out to a distance of up to 10 m. The GRP cover will then be recovered, the jumper installed and new GRP covers installed over the Edradour manifold and Victory tie-in structure. Rock will be placed over both the GRP covers and the jumper bundle.

It is estimated that the tie-in arrangements for the proposed Victory development will impact an area of seabed totalling 24,316 m^2 (0.02 km^2) (see Table 3.9).

The pipeline tie-ins will be made by a DSV lifting spools into place with the make-up to the structures and pipelines being made by diver.

The umbilical tie-ins will be made by a MSV/DSV with the make-up to the structures being made by ROV.

Table 3.9: Victory Tie-in Details

Tie-in	Diameter (NB)	Materials	Length (m)	Protection Material[1]	Seabed Footprint (m^2)
Victory Well to Victory PLEM / Pigging Skid	10 inch	Duplex or Super Duplex	30 m	6 mattresses	108
Victory PLEM / Pigging Skid to Pipeline	14 inch	Duplex or Super Duplex	40 m	15 mattresses from rock to structure	270
Pipeline to Victory PLEM / Tie-in Skid	14 inch	Duplex or Super Duplex	40 m	15 mattresses from rock to structure	270
Victory PLEM / Tie-in Skid to HTT Structure	10 inch	Flexible Pipeline, Duplex carcass	220 m	2,500 tonnes of rock and 19 mattresses	12,200 [2]
Umbilical to Tie-in Structure to Edradour Manifold	150 mm	Thermoplastic	-	2,500 tonnes or rock and 20 mattresses	11,000 [3]
Umbilical to Victory PLEM / Pigging Skid	150 mm	Thermoplastic	-	20 mattresses from rock to structure	360
Jumpers from PLEM / Pigging Skid to Victory Well	-	-	30 m	6 mattresses	108

[1] Worst case mattress dimensions are yet to be determined but are likely to be 6 x 3 x 0.3 m

[2] Includes seabed disturbance resulting from the removal of existing protection over the HTT2 structure, estimated to impact an area of up to 10,000 m^2 (0.01 km^2).

[3] Includes seabed disturbance resulting from the displacement of rock at the Edradour manifold, removal of the GRP and additional rock deposit, estimated to impact an area of up to 10,000 m^2 (0.01 km^2).

Figure 3.16: HTT1-2 Location Schematic and Required Crossings

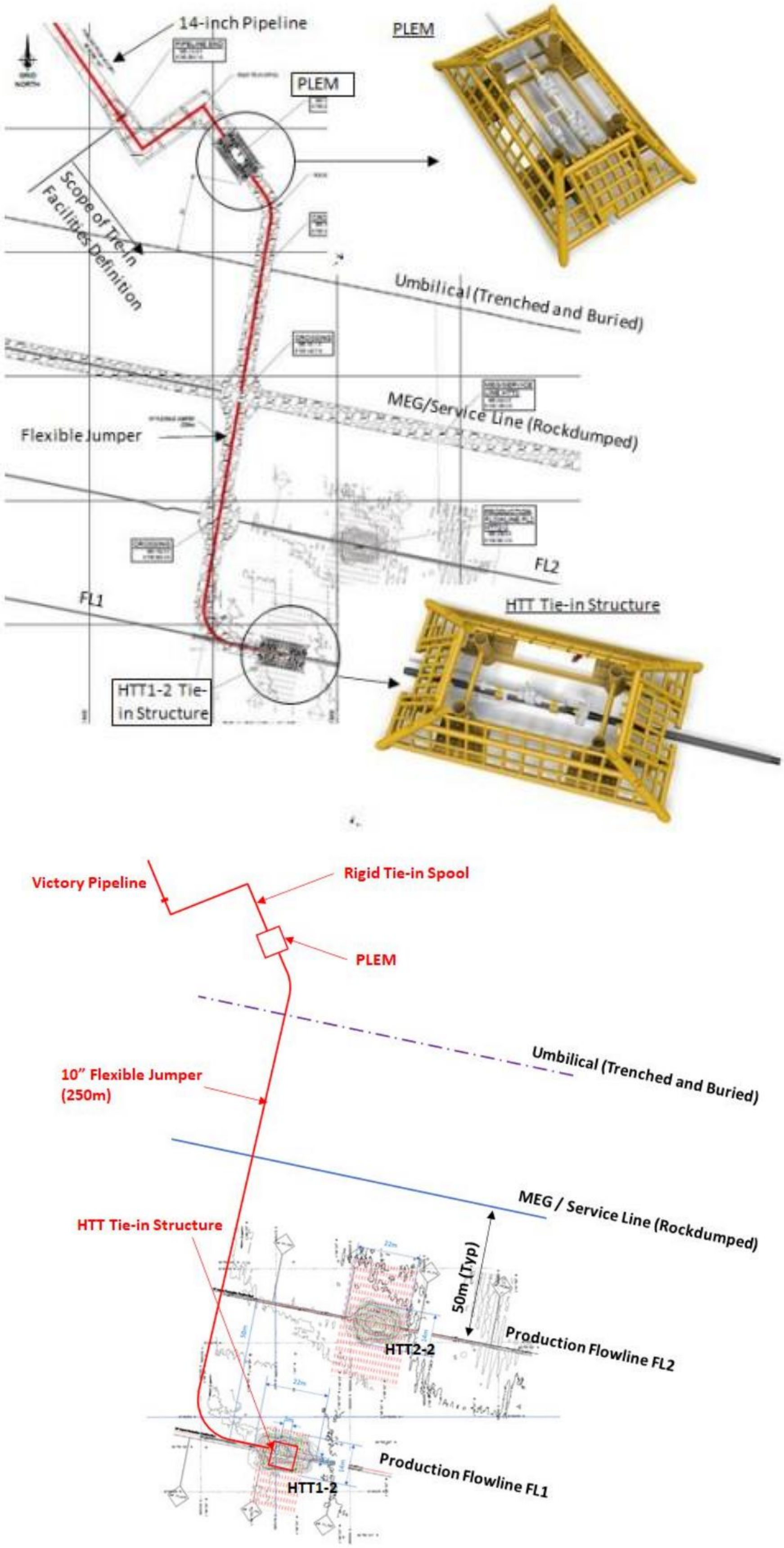
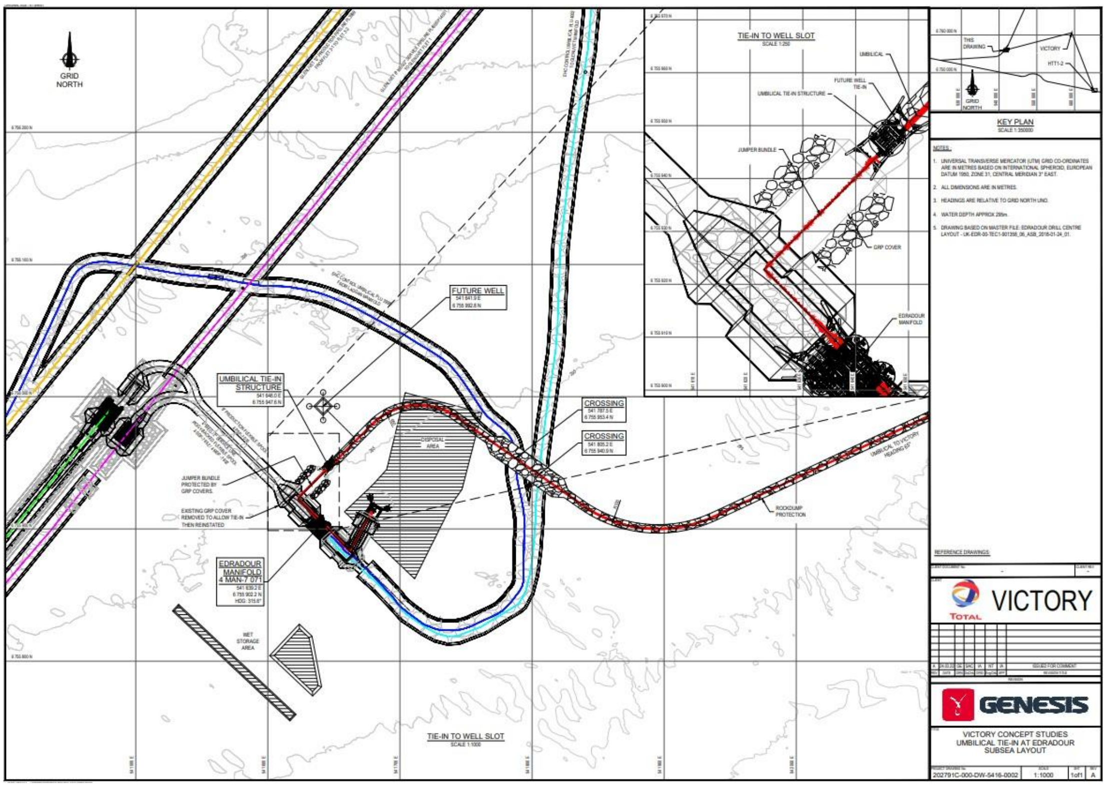


Figure 3.17: Subsea Layout of Victory Umbilical Tie-in at the Edradour Manifold



3.4.6 Hook-Up and Commissioning Operations

Where feasible, as much equipment as possible will be pre-commissioned onshore. It is anticipated that:

- The spool pieces will be hydrotested onshore and will be installed, pre-filled with chemicals to protect the infrastructure integrity typically MEG gel and potentially also dye, to facilitate leak testing;
- The umbilical will be pressure tested on completion of manufacture and will be installed, pre-filled with the control lines filled with the appropriate hydraulic fluid and the chemical injection lines will be filled with MEG or a suitable spacer chemical;
- Offshore the production pipeline will be flooded with treated water and hydrostatically strength pressure tested (typically 120% of line volume). The treated water may contain biocide, oxygen scavenger and a dye for leak testing. The flowline will then be depressured (excess water will be discharged at the pipeline ends) and left on the seabed flooded with treated water;
- Following tie-in of all the components, an overall leak test will be conducted.

Conceptually, the Victory pipeline will be dewatered from PLEM to PLEM using temporary pig launchers and receivers connected at the PLEMs. The total volume of treated water discharged to sea will be around 2,565 m^3 (based on a 16.2 km long pipeline with a 14 inch diameter). The pipeline will then be depressurised to minimise the quantity of nitrogen in the system. The pipeline will then be back-gassed from the SGP pipeline using the valving on the PLEM. This will leave a slug of nitrogen at the Victory well end of the pipeline, which will need to be blended during the start of forward flow through SGP. There are two potential blending points; one, as the Victory gas enters the SGP pipeline at the hot tap tee location and a further one at the terminal. Metering will be used to track the location of the nitrogen in the system and consideration will be given to sampling at SGP itself.

The use and discharge of chemicals during pipeline operations will be detailed and assessed in the Pipeline Operations MAT and associated Chemical Permit SAT in accordance with the Offshore Chemicals Regulations 2002 (as amended). Chemicals will be subject to an environmental risk assessment, where applicable and products with an improved environmental profile will be preferentially selected for use.

3.4.7 Vessel Requirements

The installation of the Victory subsea infrastructure will be carried out by a number of vessels as detailed in Table 3.10. All vessels will be dynamically positioned (DP).

Table 3.10: Vessel Requirements for Installation of Subsea Infrastructure

Vessel	Function	Typical Fuel Consumption[1]	Duration in Field
Survey and utility vessels[2]	Pipeline and umbilical survey, dredging top of the sand wave crests and boulder clearance (if applicable)	8 tonnes / day	45 days
Pipelay reel-lay vessel	Pipeline installation	15 tonnes / day	6 days
Umbilical lay vessel	Umbilical installation	15 tonnes / day	6 days
DSV / MSV[3]	Subsea structures installation	22 tonnes / day	91 days
Rock dump vessel	Deploy rock-dump material	15 tonnes / day	109 days
Guard Boats	Guarding pipeline and umbilical between lay and rock dumping	0.8 tonnes / day	195 days

[1] Typical fuel consumption rates from IoP (2000).
[2] It is assumed that the dredging equipment will be deployed from the survey and utility vessel.
[3] DSV / MSV will deploy mass flow excavator required to remove rock at HTT2 and Edradour tie-in points.

3.4.8 Atmospheric Emissions Summary

Table 3.11 presents the calculated emissions to atmosphere from vessel movements associated with the installation of the Victory subsea infrastructure (based on the assumptions detailed in Table 3.10).

Table 3.11: Estimated Atmospheric Emissions from Victory Installation Operations

Total Fuel Consumption (tonnes) [1]	Emissions (tonnes) [1]							
	CO_2	CO	NO_x	N_2O	SO_2	CH_4	VOC	CO_{2e}
4,333	13,865.6	68.0	257.4	1.0	17.3	0.8	8.7	14,169

[1] See assumptions in Table 3.10.
[2] Emissions factors from DECC (2008); GWP has been calculated using AR4 (IPCC, 2007).

3.5 Production

3.5.1 Production Profiles

Figure 3.18 shows the predicted P10 (maximum) case for daily production rates of gas from the Victory reservoir over an eight year period from 2024 to 2031. According to the P10 case, daily gas and condensate production from the Victory development is expected to peak around year three with a rate of 4.209 million cubic metres (148.6 million cubic feet) of gas per day and 23.6 cubic metres (15.4 tonnes) of condensate per day. Following these peaks, gas and condensate production is expected to decrease as field life continues (see Table 3.12). Formation water production is not anticipated.

When Victory gas is brought into the GLA infrastructure it will be at a higher pressure than the existing, partially depleted, fields. This would normally cause a significant reduction in the flow rate of the GLA fields into the system ('backout') but has been minimised as far as possible by dedicating one of the two main GLA 18 inch flowlines to Victory. However, some backout of the GLA fields will still occur at the SGP plant where the flowstreams are merged. The backout of the GLA gas by Victory will be accounted for in the commercial agreements between the GLA owners and the Victory owners and will essentially be handled by a proportion of Victory gas being used to substitute for any backed-out GLA fields gas. This has the effect of slightly flattening the Victory production profile in the first 2 to 3 years of field life. Later in field life, as pressure equilibrates, backout of the GLA fields by Victory no longer occurs, so the GLA owners essentially 'return' that gas to the Victory owners. Overall recovery is therefore not affected over the entire life of the field and it is anticipated that Victory will actually extend the life of the GLA fields by delaying the cessation of production for the whole system.

Figure 3.18: Victory Daily Gas Production Profiles

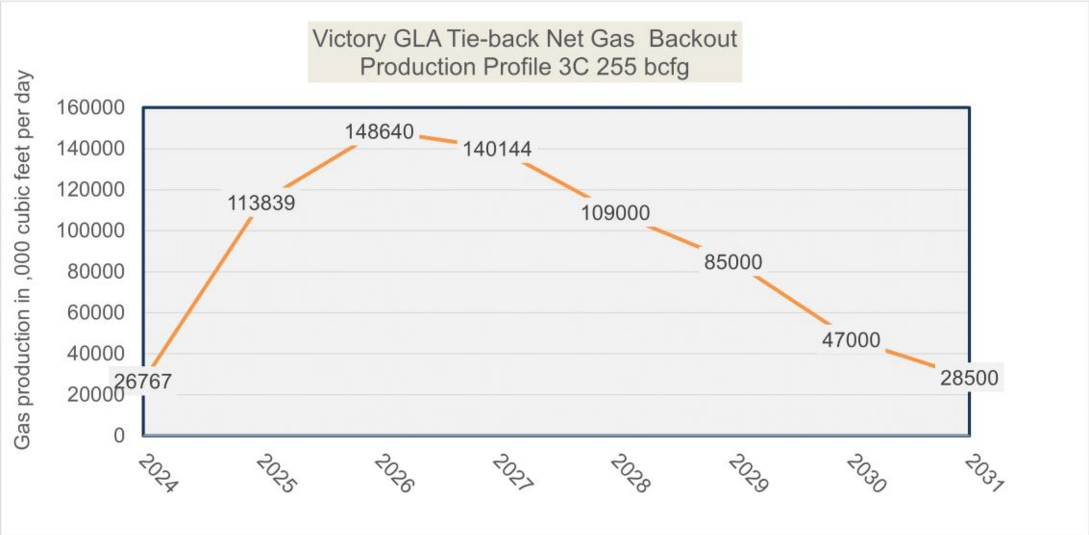


Table 3.12: Victory Field Production Profile (P10)

Year	Days of Production	Gas Production Rate (Mscf/d)	Gas Production Rate (scm/d)	Cumulative Gas Production (Mscf)	Cumulative Gas Production, (scm)	Condensate Production Rate (scm/d)	Condensate Production Rate (tonnes/d)	Cumulative Condensate Production (scm)	Cumulative Condensate Production (tonnes)
2024	90	26,767	757,956	2,409,030	68,216,040	4.26	2.77	383	249
2025	365	113,839	3,223,556	43,960,265	1,244,813,980	18.1	11.77	6,990	4,545
2026	365	148,640	4,209,009	98,213,865	2,781,102,265	23.63	15.36	15,615	10,152
2027	365	140,144	3,968,430	149,366,425	4,229,579,215	22.28	14.48	23,747	15,437
2028	365	109,000	3,086,531	189,151,425	5,356,163,030	17.33	11.27	30,073	19,551
2029	365	85,000	2,406,928	220,176,425	6,234,691,750	13.52	8.78	35,007	22,755
2030	365	47,000	1,330,890	237,331,425	6,720,466,600	7.47	4.86	37,734	24,529
2031	365	28,500	807,029	247,733,925	7,015,032,185	4.61	3	39,417	25,624
Total:				**247,733,925**	**7,015,032,185**			**39,417**	**25,624**

3.5.2 Atmospheric Emissions

As Victory will be a subsea development, it is proposed that production from the field will processed onshore at the SGP with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the Victory development. Atmospheric emissions during the Victory production phase will therefore mainly arise from power generation requirements at SGP.

As the SGP is located onshore, the emissions arising at SGP as result of the Victory development are outside of the scope of this ES. The remainder of information within this section has been provided for background information only.

The SGP is a modern asset with low GHG intensity, with annual CO_2 emissions currently at 158,000 tonnes (see Section 2.3.2 for further information). The plant is run using a single compressor and generator. When production rates were greater (between 2017 and 2021), the plant used two compressors and generators, and CO_2 emissions were approximately 200,000 tonnes per annum. The addition of Victory is expected to require use of a twin-train operation and from Q4 2024 to Q4 2029, it is predicted that annual CO_2 emissions from the SGP will revert to around 200,000 tonnes.

Production from Victory will not change the current operating conditions at SGP with respect to flaring. However, there will be temporary increases in flaring as a result of Victory production coming online due to initial start-up, planned shut down and start-up and unplanned shut down and start-up.

3.5.3 Marine Discharges

There will be no offshore marine discharges during routine production operations at the Victory field. The Victory well will be drilled at a stand-off to the water contact so formation water production is not expected. The main source of water will be from condensed water and a conservative rate of 1.0 bbl/MMscf has been assumed for design purposes, but in practice lower water production rates are likely. Any produced water generated during processing of the Victory fluids will be disposed at the SGP via the existing produced water system and is therefore outside of the scope of this ES. However, there is sufficient capacity in the water handling system at SGP to accommodate Victory.

3.6 Decommissioning

On cessation of production, the Victory field will be decommissioned in accordance with the requirements of the prevailing UK and international law.

Prior to decommissioning, a detailed comparative assessment of all available recommended abandonment options will be undertaken to establish the optimum approach. The comparative assessment will be based on technical feasibility, complexity and risk, safety, environmental impacts, effects on other sea users and cost. An Environmental Appraisal report will also be undertaken to ensure that any likely significant environmental effects are minimised, as far as possible.

It is currently anticipated that the well will be disconnected from their respective subsea architecture and will then be plugged and abandoned using a semi-submersible drilling rig or vessel with well intervention capabilities. The wellhead and casings would be cut at a depth below the mudline to remove any obstructions on the seabed and the WHPS would be removed.

All subsea infrastructure will be depressurised and flushed to remove residual hydrocarbons and chemicals and left flooded with seawater prior to abandonment, with any contaminated fluids flushed back to the SGP for treatment or flushed downhole.

As the pipeline and umbilical will be buried underneath rock it is assumed they will be disconnected with their ends cut back and buried to ensure there are no obstructions on the seabed. The tie-in spools and control jumpers, not protected by rock, would be removed.

Corallian considers removal to be the base case for mattresses during the decommissioning phase of the project. Where technically feasible, an attempt to remove all of the concrete mattresses from the seabed will be made. Where this cannot be achieved safely, a proposal will be made to OPRED to leave the mattresses *in situ*. In the case of rock dump material that has been used to protect the subsea development infrastructure, it is assumed that this will remain in place unless there are special circumstances that would warrant consideration of removal.

The subsea structures, such as the pigging skid and tie-in / protection structures would be removed, with the piles cut at a depth below the mudline to remove any obstructions on the seabed.

The vessels likely to be required to decommission the Victory subsea infrastructure are detailed in Table 3.13.

Table 3.13: Vessel Requirements for Decommissioning the Subsea Infrastructure

Vessel	Function	Typical Fuel Consumption[1]	Duration in Field
Drilling Rig	P&A well, cut wellhead and casings and remove WHPS	10 tonnes	35
DSV	Pipeline cleaning activities	22 tonnes	7
MSV	Pipeline cutting and subsea structure removal	22 tonnes	15
Survey Vessel	Decommissioning surveys	8 tonnes	4
ERRV	Patrol 500 m zone during P&A activities	8 tonnes	35

Table 3.14 presents the calculated emissions to atmosphere from vessel movements associated with the decommissioning of the Victory subsea infrastructure (based on the assumptions detailed in Table 3.13).

Table 3.14: Estimated Atmospheric Emissions from Victory Decommissioning Operations

Total Fuel Consumption (tonnes) [1]	Emissions (tonnes) [1]							
	CO_2	CO	NO_X	N_2O	SO_2	CH_4	VOC	CO_{2e}
1,146	3,667.2	18.0	68.1	0.3	4.6	0.2	2.3	3,747

[1] See assumptions in Table 3.13.

[2] Emissions factors from DECC (2008); GWP has been calculated using AR4 (IPCC, 2007).

Notwithstanding the above, the potential for the infrastructure to be re-used in the future has been considered during the design phase of the project. The casing programme for the proposed Victory development well has been designed so it is potentially suitable for future re-use as a CO_2 injection well and the design of the Victory production pipeline will also be suitable to transport dry CO_2 (see Section 2.3.4 for further details). Containment of gas in transit from the Victory reservoir to the SGP has been designed for the production of Victory gas, but the pressure tolerances are considered to be suitable for transporting CO_2 in either gaseous (low pressure) or liquid (high pressure) phase. Containment of CO_2 within the Victory structure is considered to be low-risk, as the field has contained natural gas through geological time. The scheme considers storage within the Victory closure only, without over-filling and creating a slow-moving plume within the aquifer. Only one decommissioned well (207/01-3) is located within the Victory field, c.81m downdip of the proposed Victory production well.

4 The Existing Environment

4.1 Introduction

This section describes the current environment at the proposed Victory development location. The description is largely based on data provided in the OPRED Offshore Energy Strategic Environmental Assessment (SEA) Reports (2003-2016), as well as other published data sources, supported by site-specific survey data as detailed below. The proposed Victory development is located within the SEA4 Region (the area north and west of Orkney and Shetland) (DTI, 2003) and OESEA Regional Sea 8 (the 'Scottish Continental Shelf' area) (DECC, 2016).

4.1.1 Victory Site-specific Data

Site-specific data has been collected over the main Victory site, the proposed pipeline route to the Hot-Tap-Tee No. 2 (HTT2) tieback and two proposed umbilical routes, one to the Edradour subsea manifold and one to the Glenlivet subsea manifold. The survey was conducted by Benthic Solutions Limited (BSL) on behalf of Corallian in June 2021. Note, as only the umbilical route to Edradour will be developed in the event field development consent is granted, data collected along the route to Glenlivet is not discussed in detail in this ES.

A geophysical survey was undertaken across the Victory location using a vessel-mounted multibeam echosounder (MBES) to obtain bathymetry data, and a towfish to obtain side scan sonar (SSS) data to aid in the habitat investigation of the site. Data were acquired over a 4 km by 4 km area centred on the proposed Victory well location and along 200 m wide corridors for each of the three routes. The MBES bathymetry and SSS datasets were reviewed during acquisition to identify areas of potential interest, including changes in acoustic reflectivity which may indicate sediment/habitat change.

Environmental seabed sampling was carried out at ten stations in total, seven stations (V_01 to V_07) in the vicinity of the main Victory site using an 'intelligent surveying' approach to characterise the seabed, including sampling locations 50m and 250m downstream of the proposed well location, with a further station sampled along each of the proposed routes (V_H_01 along the HTT2 route, V_E_01 along the Edradour route and V_G_01 along the Glenlivet route). The grab sampling locations conducted on the proposed routes were selected in the predominant habitat type encountered whilst factoring the likelihood of successful grab sampling due to the sediment type. Each grab location was concurrent with a camera transect (of at least 50m length). Seabed samples were acquired using a Double Van Veen grab at all stations apart from V_G_01 (along the Glenlivet route), where a Hamon grab was used to acquire the macrofauna samples. A full suite of faunal and physico-chemical samples was retrieved from each grab sampling station (see Table 4.1).

An additional eight camera transects were conducted along the routes to ground-truth and map the different habitats observed from the geophysical data: four along the HTT2 route, and two along each of the routes to Glenlivet and Edradour (see Table 4.2). Seabed video footage and still photographs were acquired using a Seabug underwater camera system.

Figure 4.1 illustrates the location of the Victory sampling stations and camera transects.

All benthic stations underwent the following sampling/sub-sampling:

- 3 x 0.1m^2 macro-invertebrate replicate samples processed over a 500µm aperture sieve;
- 1 x 0.1m^2 physico-chemical replicate, sub-sampled for particle size distribution (PSD), total organic carbon (TOC), total organic matter (TOM), moisture, heavy and trace metals (HM), and hydrocarbons (HC), at a single surface depth of 0-2cm.

The results of the analysis have been compared to a variety of reference values relating to regional background levels and threshold effect levels to aid in the interpretation of the data, including OSPAR background concentrations (BCs) and background assessment concentrations (BACs) and OSPAR effect range low (ERL) and effect range median (ERM) levels.

In addition, the findings from other operator surveys nearby to the Victory field have been used to supplement the baseline data collected by Corallian to ensure sufficient data is provided to inform the

Victory baseline appraisal and associated assessment of potential impacts on benthic receptors which may result from the proposed development (see Section 4.1.2). Corallian also commit to acquire further environmental data along the chosen pipeline and umbilical routes, as required, during the detailed engineering surveys scheduled to be undertaken in 2023. The additional data collected will be used to inform subsequent environmental assessments required to support permit applications for the proposed Victory development.

Table 4.1: Summary of Acquired Grab Samples (BSL, 2021a)

Station	Rationale	Easting (m)	Northing (m)	Depth (m)	PC	F1	F2	F3
Stations in the Vicinity of the Proposed Victory Well								
V_01	50m Downstream (SW) from the Victory PWL	559 039	6 760 005	169	Y	Y	Y	Y
V_02	250m Downstream (SW) from the Victory PWL	559 039	6 760 005	168	Y	Y	Y	Y
V_03	Repeat of GR_2_04 (Fugro, 2011)	559 711	6 758 418	149	Y	Y	Y	Y
V_04	Patch of higher reflectivity - ground-truthing the Fugro 2011 habitat map classification 'Silty gravelly sand with occasional cobbles and boulders'	557 538	6 760 986	183	Y	Y	Y	Y
V_05	Band of sediment with lower reflectivity	558 478	6 758 201	150	Y	Y	Y	Y
V_06	Patch of higher reflectivity sediment	560 414	6 761 045	173	Y	Y	Y	Y
V_07	Reference/Control station in area of similar sediment type as the PWL and 2.17km cross stream	561 169	6 759 471	158	Y	Y	Y	Y
Stations Along the Proposed Pipeline / Umbilical Routes								
V_H_01	Irregular wave formation and patch of high reflectivity on the pipeline route to HTT2	561 542	6 753 644	138	Y	Y	Y	Y
V_E_01	Striation of high and low reflectivity sediment following the current direction on the umbilical route to Edradour	551 876	6 758 232	202	Y	Y	Y	Y
V_G_01	Banding of high and low reflectivity on the umbilical route to Glenlivet	554 827	6 764 981	271	Y	Y*	Y*	Y*

Geodetics: ED50 UTM 30N 3°W
PC = Physico-chemical grab sample
F1 / F2 / F3 = Faunal grab sample replicates
Y = Good sample collected
* = Samples collected using a 0.1m2 mini-Hamon grab

Table 4.2: Summary of Completed Camera Transects (BSL, 2021a)

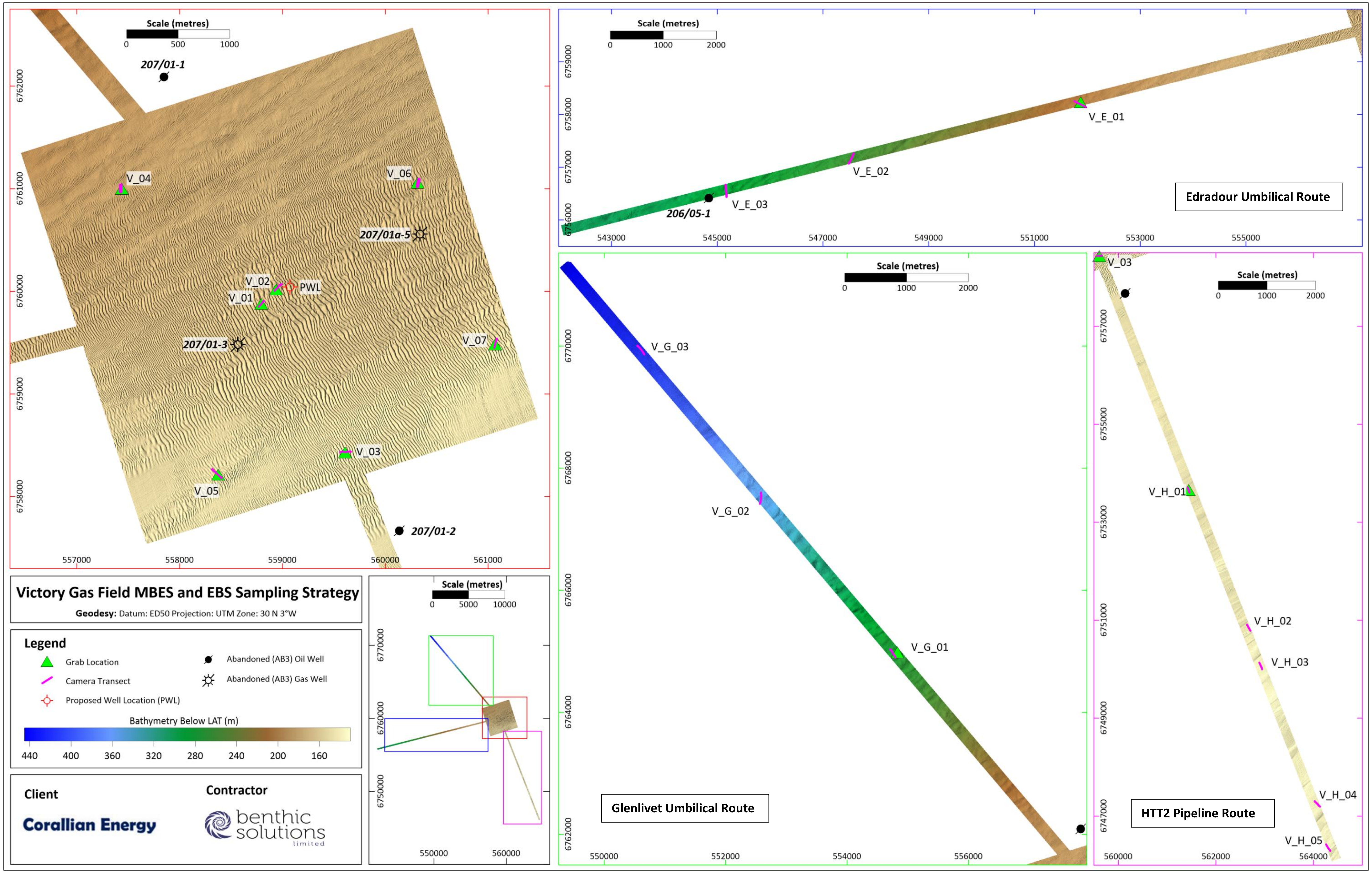
Transect[1]		Date and Time	Easting (m)	Northing (m)	Length (m)	No. Stills	Video footage (minutes)
Camera Transects in the Vicinity of the Proposed Victory Well							
V_01	SOL	20/06/21 05:27:02	559 100	6 760 057	100	20	16
	EOL	20/06/21 05:45:08	559 018	6 759 985			
V_02	SOL	20/06/21 07:46:41	558 925	6 769 893	65	14	7
	EOL	20/06/21 07:52:22	558 872	6 759 840			
V_03	SOL	20/06/21 12:20:58	559 763	6 758 426	100	12	7
	EOL	20/06/21 12:27:49	559 668	6 758 423			
V_04	SOL	19/06/21 00:35:29	557 529	6 761 020	60	9	6
	EOL	19/06/21 00:41:13	557 528	6 760 959			

Transect[1]		Date and Time	Easting (m)	Northing (m)	Length (m)	No. Stills	Video footage (minutes)
V_05	SOL	20/06/21 13:51:06	558 418	6 758 253	100	19	7
	EOL	20/06/21 13:58:58	558 500	6 758 180			
V_06	SOL	20/06/21 03:25:31	560 428	6 761 076	65	11	6
	EOL	20/06/21 03:35:30	560 414	6 761 012			
V_07	SOL	20/06/21 10:16:27	561 187	6 759 524	95	14	7
	EOL	20/06/21 10:23:41	561 160	6 759 436			
Camera Transects Along the Proposed Pipeline Route to HTT2							
V_H_01	SOL	21/06/21 05:01:37	561 555	6 753 593	105	16	8
	EOL	21/06/21 05:10:30	561 524	6 753 695			
V_H_02	SOL	21/06/21 04:03:06	562 806	6 750 774	145	20	11
	EOL	21/06/21 04:14:51	562 739	6 750 902			
V_H_03	SOL	21/06/21 03:11:47	563 045	6 749 988	150	19	12
	EOL	21/06/21 03:23:53	562 990	6 750 131			
V_H_04	SOL	21/06/21 01:52:52	564 226	6 747 190	155	21	10
	EOL	21/06/21 02:03:58	564 124	6 747 294			
V_H_05	SOL	20/06/21 00:58:43	564 438	6 746 281	160	19	10
	EOL	21/06/21 01:10:05	564 356	6 746 417			
Camera Transects Along the Proposed Umbilical Route to Edradour							
V_E_01	SOL	22/06/21 03:57:24	552 073	6 758 130	245	29	19
	EOL	22/06/21 04:17:24	551 853	6 758 241			
V_E_02	SOL	22/06/21 02:39:15	547 599	6 757 081	210	32	17
	EOL	22/06/21 02:56:56	547 714	6 757 278			
V_E_03	SOL	21/06/21 22:21:24	545 278	6 756 428	225	30	18
	EOL	21/06/21 22:38:37	545 261	6 756 655			
Camera Transects Along the Proposed Umbilical Route to Glenlivet							
V_G_01	SOL	23/06/21 06:58:36	554 813	6 765 021	180	16	14
	EOL	23/06/21 07:12:10	554 899	6 764 891			
V_G_02	SOL	23/06/21 11:30:29	552 683	6 767 563	190	26	13
	EOL	23/06/21 11:43:46	552 664	6 767 401			
V_G_03	SOL	23/06/21 12:46:28	550 651	6 769 990	160	26	16
	EOL	23/06/21 13:02:33	550 764	6 769 850			

Geodetics: ED50 UTM30N 3°W

[1] EOL = End of Line; SOL = Start of Line

Figure 4.1: MBES Bathymetry Data and Environmental Sampling Strategy for Victory Survey Area (BSL, 2021a)



4.1.2 Site-specific Surveys in the Wider Area

The oil and gas infrastructure in the wider area has been subject to a number of site-specific surveys over the years as illustrated in Figure 4.2. Several of these surveys are in close proximity to the proposed Victory field development area and have therefore been used to inform the environmental baseline description, where relevant, including:

- Laggan Development – Yell Sound Pipeline Route EBS (Fugro, 2009a): presents the results of the EBS undertaken along the proposed pipeline route from the existing Laggan well 206/1a-4az to the inshore limit of acquisition within Yell Sound in the Shetland Islands, approximately 125km. The HTT2 pipeline tie-in location is located within the survey corridor and is located between two of the Yell Sound environmental stations (Yell_305 and Yell_306).
- Glenlivet Pipeline & Umbilical Route Surveys (Fugro 2011): presents the results of an EBS undertaken along proposed routes from Glenlivet. Route 2 crosses through the main Victory field survey area (over the top of the 207/1-3 discovery well). As such, one of the Victory stations (V_03) is directly comparable with a station previously sampled along Route 2 (station (GR_2_04).
- Edradour Field – Benriach Environmental Survey (MMT, 2019a): presents the results of a geophysical and environmental survey undertaken within a 3 km by 3 km area centred on Benriach (UKCS Blocks 206/4a and 206/5c) in the vicinity of the Edradour field. Grab samples were only taken from one station (BNR-E-A), located at the proposed centre well location of the Benriach survey area. Two imagery transects where conducted with an additional transect between the centre well locations of the Benriach and Glendronach survey areas.
- Edradour Field – Glendronach Environmental Survey (MMT, 2019b): presents the results of a geophysical and environmental survey undertaken within a 3 km by 3 km area centred on Glendronach (UKCS Blocks 206/4a, 206/5c) in the vicinity of the Edradour field. Grab samples were taken from ten sites, with two imagery transects conducted. An additional transect was conducted between the proposed centre well locations of the Glendronach and Benriach survey areas.
- Benriach Rig Site Survey (Fugro, 2019): presents the results of an EBS undertaken in the Benriach field. Grab samples were acquired from eleven sites around the proposed re-spud well location, orientated to the prevailing current direction, in addition to ten imagery transects.
- Glenlivet Rig Site Survey (Fugro, 2015): presents the results of a geophysical and environmental survey undertaken within a 4.365 km by 4.930 km area centred on the proposed Glenlivet well locations (UKCS Block 214/30a). Grab samples were taken from five sites, with a single 7.2km camera transect acquired which encompassed the area north and east of the drilling rig.
- Edradour Environmental Surveys (Fugro 2009b, Fugro 2012a; Fugro 2012b): presents the combined geophysical and environmental surveys undertaken within the Edradour Development Area, which encompasses the Edradour manifold, the pipeline route between Edradour and the In-Line Tee 3 (ILT3) on the Laggan-Tormore pipeline and the umbilical route between the Laggan and Edradour manifolds (as document in Total, 2012).

Figure 4.3 shows the environmental stations from the above listed surveys in relation to the Victory stations and camera transects.

Figure 4.2: Environmental Surveys Undertaken in the Wider Area to Victory

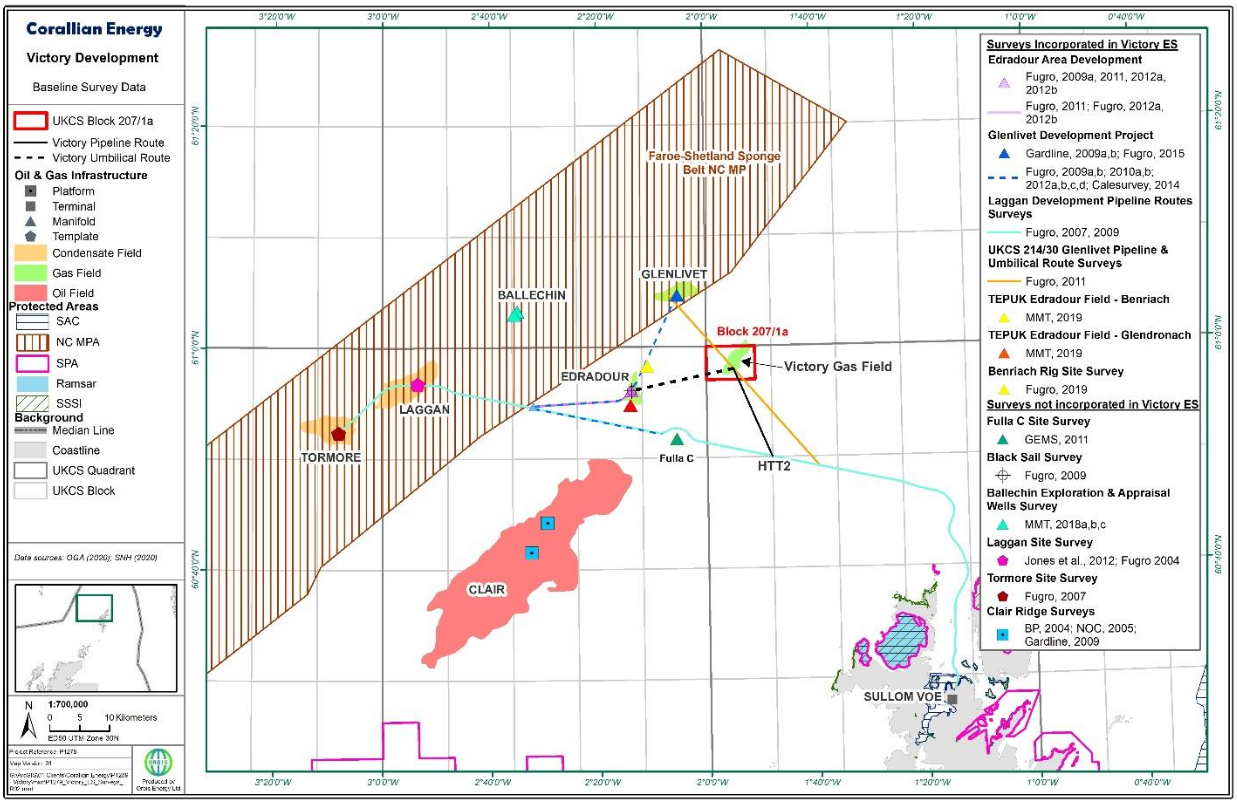
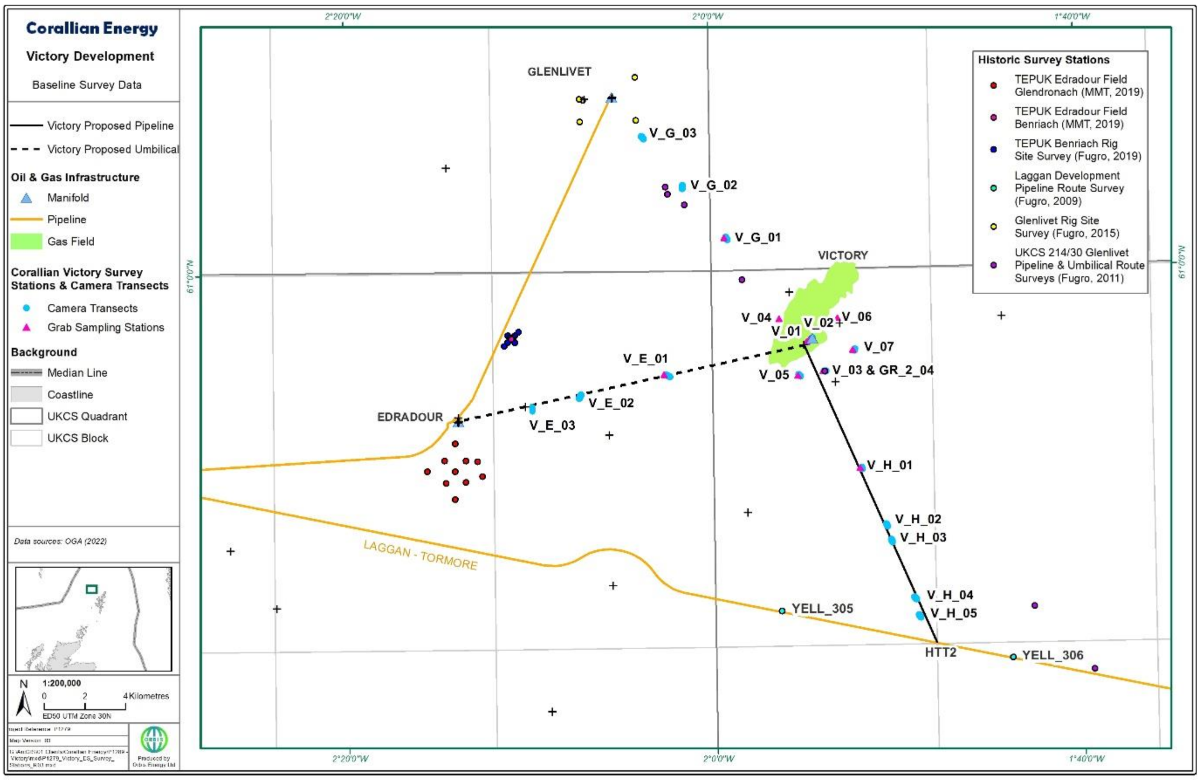


Figure 4.3: Spatial Extent of Environmental Sampling in Close Proximity to Victory



Note, the exact location of the sampling stations in the Edradour Development Area (Fugro 2009b, Fugro 2012a; Fugro 2012b) are unknown and are therefore not shown in the above figure.

4.2 Physical Environment

4.2.1 Bathymetry and Seabed Features

The proposed Victory development is located close to the edge of the West of Shetland continental shelf. The slope beyond the shelf-edge to the north west of the proposed development forms the eastern side of the Faroe-Shetland Channel, the major topographical feature in the region. This is an extensive deep water channel surrounded by the West of Shetland continental shelf, the Faroe shelf, and the Wyville-Thompson Ridge. The average depth of the Faroe-Shetland Channel is approximately 1,200 m and it reaches a maximum depth of around 1,700 m in the north where it opens out into the Norwegian Sea basin (DTI, 2003).

The water depth at the proposed Victory well location was recorded as 169.3 m and ranged from 195.8 m in the NW corner of the main Victory site survey area to 148.4 m in the SE corner (Figure 4.1).

Along the HTT2 route water depths decrease towards Shetland, from a maximum depth of 170 m to a minimum depth of 126 m at the hot tap tee (Figure 4.4). The water depth profile along the pipeline route is presented in Figure 4.5.

Along the Edradour route water depths sloped gently away from the Victory site reaching a maximum depth of 303.9 m (Figure 4.6).

The proposed Victory development falls partially within the area known as the 'iceberg plough mark zone' (Bett, 2003). Iceberg sour areas are often defined by large proportions of cobbles and boulders, which may act as a stony reef or provide a substrate for biogenic coldwater coral reefs. However, no iceberg scours were evident in the Victory survey area from the SSS and bathymetry data, although cobbles and boulders, potentially deposited from glacial activity, were present (BSL, 2021a).

The seabed was characterised by sand ripples and megaripples across the main Victory site. Smaller megaripples were focussed in the north (approximately 8 to 10 m in length) with larger meggaripples (approximately 15 to < 50 m) observed in the south (BSL, 2021a). An extensive area of megarippled sand was also observed along the section of the Glenlivet Route 2 survey which crosses through the main Victory site. The Glenlivet survey observed megaripples with typical wavelengths of about 25 m to 35 m and heights up to 1.5 m, with their crests orientated approximately north-northwest to south-southeast (Fugro, 2011).Sediment changes were observed across the HTT2 route, with a largely sandy seabed in the north to sand with gravel, cobbles, and occasional boulders in the southern section of the route. Isolated megaripples, slopes and elevations were also apparent along the route corridor. Coarse sand and gravel intersected by ribbons of clear sand have previously been recorded at the HTT2 location during the Yell Sound pipeline route survey (Fugro, 2009a).

The Edradour route displayed a sandy seabed with isolated megaripples and bands of megarippled sands with gravel, cobbles and boulders present along most of the corridor in varying densities. Additionally, seabed scars from fishing activity were observed along both the HTT2 and Edradour routes (BSL, 2021a). Previous surveys undertaken at Edradour have observed a thick veneer of sand extending across the Edradour drill centre area, with a series of curvilinear and linear deposits with some sand rippling present in the north (Fugro, 2009b).

Figure 4.4: Bathymetry Along the Proposed Pipeline Route from Victory towards HTT2

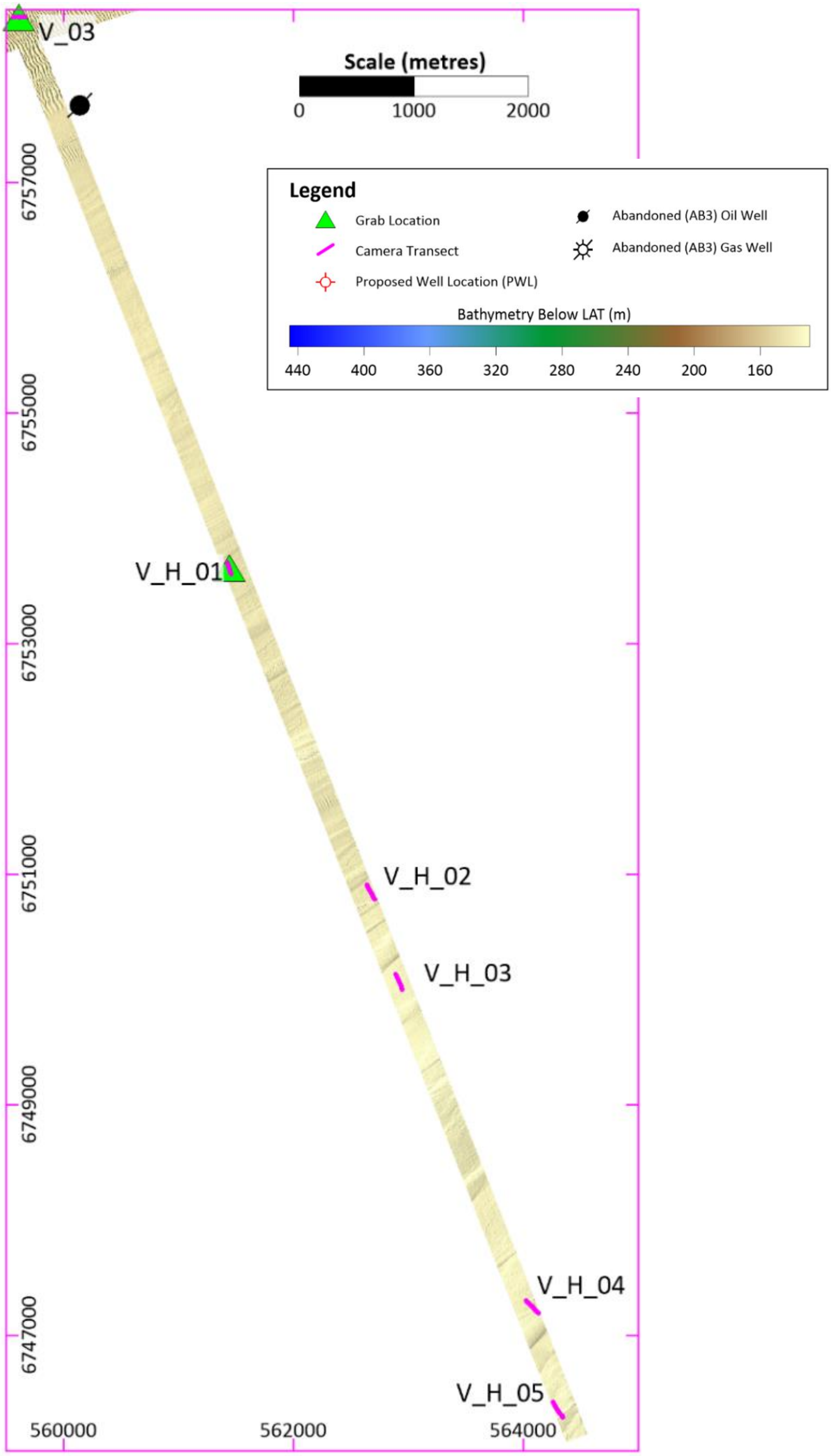


Figure 4.5: Water Depth Profile along the Proposed Victory Pipeline Route

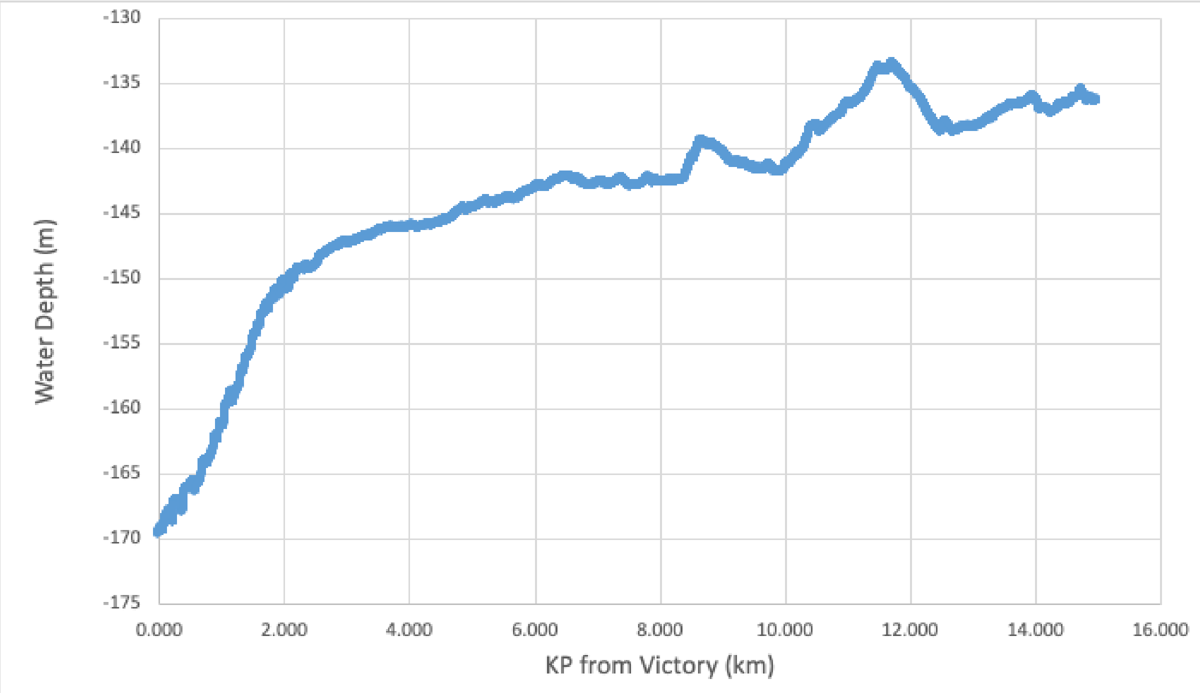
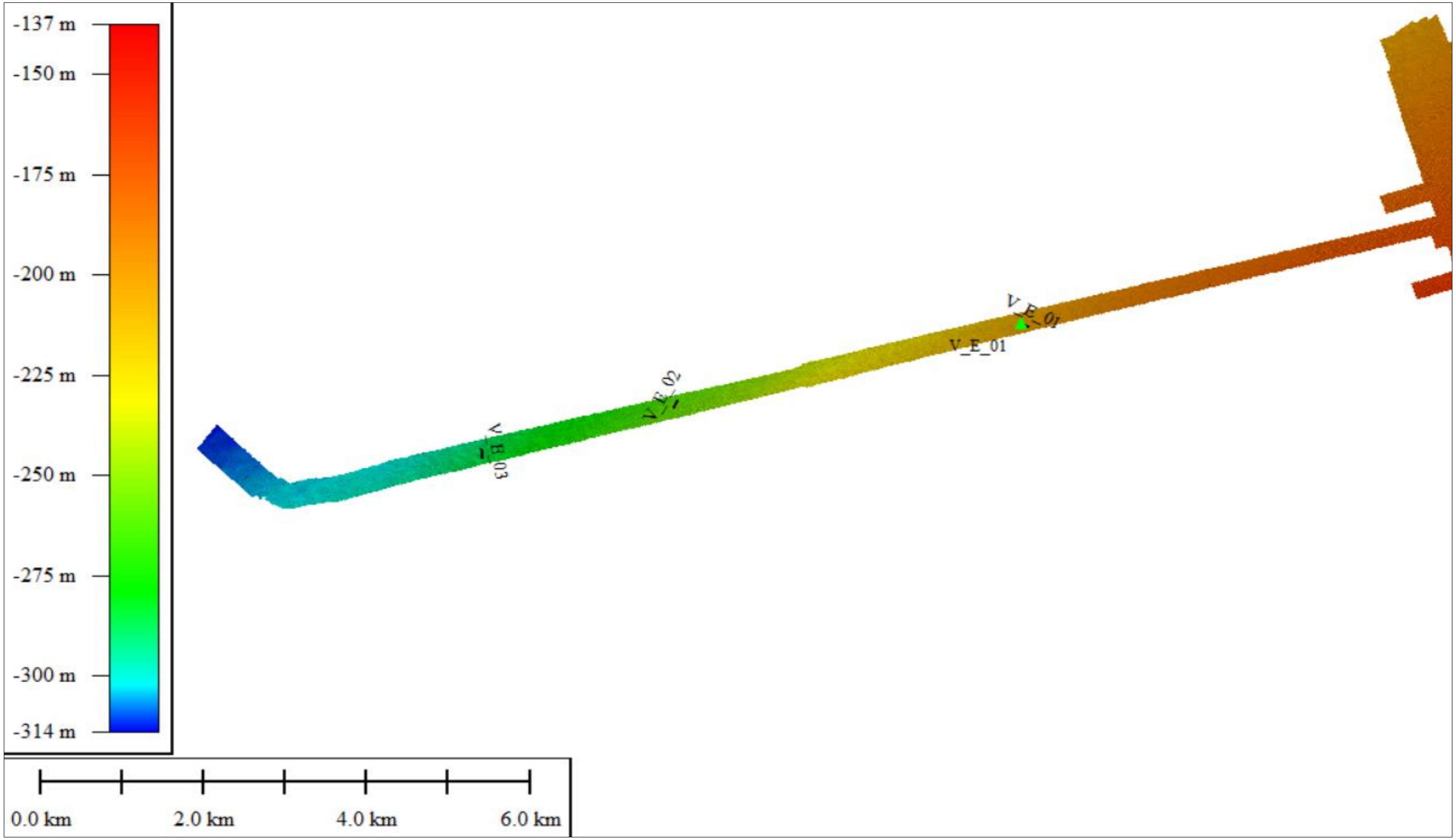


Figure 4.6: Bathymetry Along the Proposed Umbilical Route from Victory (KP0) towards Edradour



4.2.2 Seabed Sediments

The nature of the local seabed sediments is a determining factor in the benthic communities present in the area (Kostylev, 2012). The infilling of iceberg ploughmarks over time on the West of Shetland shelf and slope has created a complex mosaic of seabed habitats alternating between areas of coarse (cobbles and boulders) and fine sediment (Bett, 2003).

Particle Size Analysis

Most benthic organisms exhibit preferences for sediment with particular grain size characteristics. In addition, many contaminants, particularly metals and hydrocarbons, are strongly associated with finer fractions in sediment. Determination of sediment particle size across an area is therefore important to understanding the benthic community.

Sediment samples gathered from the Victory area were subjected to particle size analysis (PSA). The results of the PSA suggest there is a relatively consistent sediment type across most of the stations. The seabed sediments showed an overall sand dominance (mean 90.9%) with minimal gravel (mean 5.44%) and fines content (mean 3.64%). The percentage contribution of sand ranged from 76.0% at station V_06 to 96.1% at station V_02, with 80% of the sampling locations showing at least 90% sand. Gravel content was highest at station V_06, accounting for 22.9% of the sediment, and likely relates to the area of higher reflectivity at this station. The proportion of sand did not correlate significantly with any other particle size characteristics, highlighting the general consistency of seabed sediments across the survey and the lack of any clear environmental gradients across the survey area (BSL, 2021a).

The samples collected in the survey area were represented by three Folk classifications with 60% of stations classified as 'Slightly gravelly sand' and 30% of stations classified as 'Gravelly sand'. One station (V_G_01) had an increased fines content that led to the classification of 'Slightly gravelly muddy sand' (Folk, 1954; BSL, 2021a).

Sand-dominated sediments with also recorded at the Yell Sound stations closest to HTT2 (Fugro, 2009a), at GR_2_04 along the Glenviet Route 2 survey (Fugro, 2011) and at the Glendronach stations, immediately south of the Edradour manifold (MMT, 2019b).

Organic Matter and Organic Carbon

Determining the organic content of sediments is also important to understanding benthic communities. Organic matter is a food source for suspension and deposit feeders and its availability in the sediments can therefore influence benthic communities. An overabundance may lead to reductions in species richness, abundance and biomass (Hyland *et al*., 2005). In addition, many contaminants are strongly associated with organic carbon.

Total organic carbon (TOC) levels recorded at the Victory survey area were low throughout (mean 0.13%), reflecting an organically deprived environment considered typical of the region due to the dominance of the sand fractions. It appears unlikely that there has been any influence on TOC from drilling activities across the Victory survey area, due to the low levels of TOC recorded. TOC levels recorded during previous regional surveys near the Victory field were also relatively low, reflecting the low fines and high sand content of the sediment (Fugro 2011; 2015; MMT, 2019a).

Total organic matter (TOM) levels recorded across the Victory survey area were low (mean 1.15%) and comparable to mean TOM levels recorded during the three other regional surveys within the vicinity of the Victory field. The organic content of the sediments across the Victory area is therefore unlikely to be acting as a reducing factor for benthic abundance, biomass and species diversity (Hyland *et al*., 2005).

Sediment Hydrocarbons

Marine sediments can contain hydrocarbons derived from both natural (geochemical processes and biosynthesise) and anthropogenic sources (e.g. oil spills). The exceedance of background hydrocarbons levels in marine sediments can indicate past and/or present anthropogenic sources. Crude oil is a complex mixture of compounds, including n-alkanes and aromatics (e.g. polycyclic aromatic hydrocarbons; PAHs). These groups can be determined individually, but they may also be analysed as total hydrocarbons (Cefas, 2001). A summary of the sediment hydrocarbon concentrations recorded in and around the Victory area are presented in Table 4.3.

Total hydrocarbon concentrations (THCs) of the sediments recorded in the Victory survey area were generally consistently low, ranging from 0.45 mg.kg-1 at station V_01 (in the main Victory area) to 2.03 mg.kg-1 at station V_G_01 (along the Glenlivet route), followed by 1.81 mg.kg-1 at station V_04 (in the main Victory area). . There were no significant correlations between observed THC levels and any physio-chemical sediment characteristics (BSL, 2021a). All stations remained well below the OSPAR 50ppm contamination threshold (OSPAR, 2006).

The carbon preference index (CPI) is used to assess the relative contribution from petrogenic (petroleum-related) and biogenic (natural) sources in hydrocarbon samples. The CPI for the full saturate range (nC10 to nC37) was fairly consistent, ranging from 1.17 at station V_03 to 2.54 at V_04 (both of these stations are located within the main Victory area), with an overall mean of 1.8. These results indicate a minor dominance of biogenic, odd-carbon numbered alkanes which are likely to be mostly allochthonous in origin (i.e. originated at a distance from their present location).

Pristane to phytane (types of n-alkane) ratios can also provide information on the relative contribution of biogenic hydrocarbon sources. Pristane is primarily biogenic in origin, whilst phytane is rarely produced biogenically and, in the natural environmental, it is generally absent or only present at low concentrations (McDougall, 2000). A lower pristane to phytane ratio indicates both biogenic and petrogenic sources of n-alkanes, whilst high ratios indicate a dominance of biogenic sources for the n-alkanes. The Victory survey found generally high ratios of pristane to phytane, indicating a dominance of the more biogenic pristane, suggesting a general biogenic influence from potential planktonic and terrestrial inputs across the Victory survey area.

Polycyclic aromatic hydrocarbons (PAH) are largely formed by the incomplete combustion of organic matter. Total PAH concentrations were below the Limit of Detection (LoD) throughout the Victory survey area (BSL, 2021a).

Table 4.3: Summary of Seabed Sediment Hydrocarbon and Heavy Metal Concentrations (BSL, 2021a)

Station	Depth (m)	Distance from Nearest Well (m)	THC ($mg.kg^{-1}$)	Carbon Preference Index	Pristane / Phytane Ratio	Total PAHs ($\mu g.kg^{-1}$)
V_01	169	707	0.45	2.34	NC	<34
V_02	168	505	0.54	1.78	1.39	<34
V_03	149	864	0.65	1.17	NC	<34
V_04	183	1,145	1.81	2.54	1.24	<34
V_05	150	1,283	1.58	2.47	1.51	<34
V_06	173	495	1.53	1.71	NC	<34
V_07	158	1,366	1.40	1.32	NC	<34
V_H_01	138	4,263	1.00	2.07	NC	<34
V_E_01	202	4,320	1.05	1.80	1.32	<34
V_G_01	271	4,184	2.03	1.18	1.76	<34
Mean			1.20	1.84	NC	NC
SD			0.52	0.49	NC	NC
CV (%)			43.4	26.4	NC	NC
Comparable Historic Station						
GR_2_04 (Fugro, 2011)	142	864	0.30	1.46	NC	13
Regional Comparison						
Glenlivet Pipelines & Umbilicals (Fugro, 2011)		Mean	1.1	1.53	2.00	16
		SD	0.9	0.14	0.38	4
		CV (%)	81.8	9.2	19.0	25.0
Glenlivet (Fugro, 2015)		Mean	1.5	1.63	2.00	33
		SD	0.4	0.02	0.38	9
		CV (%)	26.7	1.2	19.0	27.3
Edradour (MMT, 2019a)		Mean	1.18	1.85	NC	-
		SD	0.63	0.84	NC	-
		CV (%)	53.4	45.2	NC	-

NC = Not calculated due to values being below the LoD
'-' = No value reported

Heavy and Trace Metals

Heavy metals such as copper (Cu), lead (Pb) and zinc (Zn), are generally persistent and have a tendency to bioaccumulate in the tissues of exposed organisms, particularly species living on or within the seabed sediments, where they can have toxicity impacts on the receptor and subsequently become concentrated through higher levels of the food web. Metal concentrations in uncontaminated marine sediments generally exceed those found in overlying seawater by three to five orders of magnitude, since the buffering effects of saline water cause many metals to be rapidly precipitated out of seawater (Bryan and Langston, 1992).

The biological or ecological effects of metals on organisms has been investigated and researchers have defined the term 'effect range low' (ERL) as the lowest concentration of a metal which produces adverse effects in 10% of the data reviewed, additionally the 'effect range median' (ERM) designates the level at which half of the studies reported harmful effects. Therefore, metal concentrations below the ERL value are unlikely to produce harmful effects, while levels above the ERM value are likely to be toxic to some marine organisms (BSL, 2021a).

Table 4.4 presents a summary of total heavy and trace metal analysis from the Victory survey and from regional surveys in the vicinity of the Victory field.

Barium in the form of barite is a weighting material used to increase the density of drilling muds and can contain measurable concentration of heavy metals as impurities, including cadmium, chromium, copper, lead, mercury, and zinc (NRC, 1983; McLeese *et al*., 1987). The Victory survey showed low levels of natural barium, ranging from 102 mg.kg-1 at station V_05 to 360 mg.kg-1 at station V_04 (both of these stations are located within the main Victory area) (BSL, 2021a; Table 4.4). These levels were comparable to the levels recorded during previous surveys at the Glenlivet and Edradour fields (Fugro, 2011; 2015; MMT, 2019a), which found mean concentrations of between 212 mg.kg-1 and 312 mg.kg-1. The low levels indicate little or no anthropogenic contamination from drilling activities in the area.

Overall, metal concentrations across the Victory survey area were consistently low, with many displaying similar patterns of distribution. All analysed metals exhibited concentrations below the NOAA ERM and ERL values, except for arsenic at V_H_01, along the HTT2 route (10.0mg.kg^{-1}; Table 4.4), which was above the NOAA ERM value.

The low levels of metals across the survey area suggests the area is an undeveloped offshore environment, this is supported by the levels of cadmium and mercury which are often associated with drilling activities as they were below the limit of detection as almost every station (BSL, 2021a).

Comparisons with Regional Survey Data

The historical regional data within the vicinity of the Victory field used the same analytical techniques as the Victory survey and showed comparable results.

The environmental baseline surveys conducted over the Glenlivet and Edradour Development Areas found that concentrations of THC, PAHs and heavy metals were all within background levels for the region, indicating little or no inputs from anthropogenic activity.

Two samples of slightly elevated levels of THCs and PAHs were recorded at two stations around Edradour (THCs: 5.30 and 5.50 µg/g) although it is considered that the most likely source of this slight elevation in hydrocarbons was due to diffuse low level contamination from shipping activities.

Hydrocarbon concentrations at the Yell Sound environmental stations were also lower than the mean values quoted by UKOOA (2001) for the Northern North Sea and, although station Yell_305 exhibited markedly higher levels of selected metals (As, Ni, Sn and Al) (Fugro, 2009a).

Table 4.4. Total Heavy and Trace Metal Concentrations (mg.kg^{-1} or ppm) (BSL, 2021a)

Station	Depth (m)	Distance from Nearest Well (m)	AS	Cd	CR	Cu	Pb	Hg	Ni	V	Zn	Al	Fe	Ba
V_01	169	707	4.9	0.3	9.1	11.4	11.6	<0.01	5.1	12.7	50.3	13,000	5,700	184
V_02	168	505	4.5	<0.1	7.6	4.1	7.3	<0.01	4.1	11.2	18.1	12,800	5,090	207
V_03	149	864	6.5	<0.1	7.0	3.7	9.3	<0.01	4.9	12.8	16.2	13,000	5,270	164
V_04	183	1,145	4.8	<0.1	9.6	4.8	17.6	<0.01	4.6	13.5	18.1	13,800	5,840	360
V_05	150	1,283	7.3	0.2	7.4	4.6	30.5	<0.01	4.9	13.6	16.2	8,990	5,220	102
V_06	173	495	3.8	<0.1	14.3	6.2	22.6	<0.01	5.7	19.1	18.3	15,200	8,560	220
V_07	158	1,366	5.7	<0.1	8.2	4.8	8.0	<0.01	4.5	12.9	16.2	12,800	4,970	172
V_H_01	138	4,263	10.0	<0.1	14.9	9.6	15.2	<0.01	12.6	29.7	25.0	24,300	11,000	271
V_E_01	202	4,320	4.7	<0.1	10.0	6.1	13.9	<0.01	6.2	15.5	46.3	15,100	6,220	327
V_G_01	271	4,184	3.5	<0.1	10.9	5.4	9.5	<0.01	5.5	13.5	19.2	16,400	6,820	210
Mean			5.6	NC	9.9	6.1	14.6	NC	5.81	15.5	24.4	14,539	6,469	222
SD			1.9	NC	2.8	2.5	7.4	NC	2.5	5.4	12.9	3,967	1,921	78
CV (%)			34.8	NC	28.0	41.2	50.5	NC	42.4	35.2	52.9	27.3	29.7	35.1
Comparable Historic Stations														
GR_2_04	142	864	3.5	0.1	-	6.8	1.1	0.01	-	15.6	-	-	-	155
Regional Comparison														
Glenlivet Pipelines & Umbilicals (Fugro, 2011)		Mean	2.1	0.2	-	23.9	5.4	0.02	-	29.8	-	-	-	312
		SD	1.6	0.1	-	11.9	2.0	0.01	-	12.1	-	-	-	58
		CV (%)	76.2	50.0	-	49.8	37.0	66.7	-	40.6	-	-	-	18.6
Glenlivet (Fugro, 2015)		Mean	4.9	0.09	22.5	4.7	9.2	0.0017	9.9	26.3	19.4	20,440	16,680	230
		SD	0.8	0.02	5.0	0.8	0.6	0.0004	2.2	2.6	2.8	1,014	3,564	45
		CV (%)	16.3	24.4	22.2	17.1	6.7	22.3	22.2	9.9	14.4	5.0	21.4	19.6
Edradour (MMT, 2019a)		Mean	7.6	NC	11.9	6.5	8.8	NC	11.6	20.4	13.5	15,870	8,093	212
		SD	1.8	NC	2.1	2.9	1.5	NC	2.8	3.0	3.1	1,657	962	22.8
		CV (%)	23.3	NC	17.9	44.0	16.7	NC	24.1	14.8	22.6	10.4	11.9	10.7
Reference Levels														
OSPAR ERL (OSPAR, 2009a)			8.20	1.20	81	34	46.7	0.15	20.9	-	150	-	-	-
OSPAR ERM (OSPAR, 2009a)			70	9.60	370	270	218	0.71	51.6	-	410	-	-	-
Key														
(blue shading)	Exceeds the reference levels		NC = Not calculated due to values being below the LoD; '-' = No value reported											

4.2.3 Hydrography and Metocean Conditions

Currents and Tides

The West of Shetland area, within which the Victory Development is located, is characterised by persistent, long-period swells, complex current regimes and rapidly changing weather conditions. The deep water over the edge of the continental slope West of Shetland is exposed to a large fetch and strong winds, particularly from the west and southwest. These conditions generate an extreme wave regime in the area, which is more severe than that experienced in the northern North Sea.

Due to its location at the edge of the continental shelf, the current regime around the proposed Victory development is influenced by both localised tidal movements around land masses on the shelf and the movement of oceanic water masses in the Faroe-Shetland Channel itself. Cold Norwegian waters fill the Faroe-Shetland Channel to a depth of around 500 m below the surface. These dense cold waters flow along the bottom of the channel in a south-westerly direction, while a warmer layer of water moves over the top in the opposite direction from the North Atlantic (Metoc, 2002). This warmer North Atlantic water flows in from the southwest, dividing into northern and southern branches, with the southern branch passing in a north-easterly direction along the continental slope and shelf to the West of Shetland.

The European Slope Current (ESC, synonymous with the Shelf Edge Current, SEC) is a feature flowing along the continental slope. The ESC exhibits weaker flows in spring and stronger flows in autumn, mean current speeds are estimated to be between 0.05 and 0.2ms^{-1}, with higher speeds where the flow is 'squeezed' by depth contours. The maximum current in summer is at about 200 m depth, but in winter flow is much more uniform throughout the water column, with flood streams generally flowing from west to east (DECC, 2016).

Tidal current speed and direction measured at the nearest Admiralty tidal diamond to the proposed Victory development (Tidal Diamond H, Admiralty Chart 245) indicate that the maximum tidal rates in the region of the proposed development are 0.26 and 0.1 ms^{-1} respectively for spring and neap tides (Hydrographer of the Navy, 2011).

Significant Wave Height

Annual mean significant wave height in the vicinity of the Victory development ranges from 2.41m – 2.70m (Marine Scotland, 2021a).

Wind Regime

Although offshore winds around the proposed Victory development may blow from any direction, they principally blow from west to south-west, with winds of force 5 (8m/s) or greater reported 70% of the time in winter and 30% of the time in the summer (DECC, 2016).

Temperature and Salinity

The area West of Shetland has a mild maritime climate, due to the prevailing south-westerly winds bringing warmer air from the Gulf Stream and the warming influence of the North Atlantic current (UKHO, 2006). The average sea surface temperature across the Victory area in West of Shetland waters ranges from 9-10°C, and the average near-bed temperature ranges from 8-9°C (Marine Scotland, 2021a).

During winter months off the West of Shetland (December to April) the water column is vertically very well mixed, and isotherms and isohalines are almost vertical. Salinity increases in deeper waters (greater than 100m) and on the outer parts of the shelf the water is of Atlantic origin (greater than 35.2‰) (DECC, 2016). Annual mean surface salinity in the vicinity of the Victory development is 35 ppt (Marine Scotland, 2021a).

4.3 Biodiversity

This section describes the species and habitats that have been recorded in the area surrounding the Victory field that could be affected by the proposed development. Where relevant, emphasis is placed on the presence of priority marine features (PMFs) which are habitats and species that are considered to be nature conservation priorities in Scottish waters either due to being under threat or in decline, or being keystone species which are integral to community function (SNH, 2014; Tyler-Walters *et al.,* 2016). In addition, species or habitats of conservation importance have been identified, including those listed on Annex I or Annex II of the EU Habitats and Birds Directives and the OSPAR List of Threatened and / or Declining Species (OSPAR, 2016).

4.3.1 Plankton

Plankton consist of organisms that drift with the ocean currents and can be divided into phytoplankton (plants) and zooplankton (animals). The turbulence of the shelf waters brings up nutrients from the depths of the channel making them available for enhanced plankton productivity near to the shelf edge (Reid *et al*., 2003).

During spring, an increase in day length and temperature, coupled with the supply of nutrients released during winter mixing of the water column, results in the rapid growth of the phytoplankton population. Although the size and timing of this bloom varies from year to year, in the relatively cold waters in the West of Shetland, it generally peaks in May. The phytoplankton bloom is followed by a similar rapid increase in the zooplankton population as they feed on this increased food source. Phytoplankton levels drop as the nutrients in the surface waters become depleted and as a result of zooplankton grazing (Miller & Wheeler, 2012). A secondary phytoplankton bloom occurs in autumn, but is less pronounced in the open waters West of Shetland than in the North Sea.

Plankton communities in the Victory area are greatly influenced by the inflow of Atlantic Ocean water through the Faroe-Shetland Channel (Johns and Wootton, 2003). Phytoplankton assemblages are likely to be a mixture of oceanic and neritic (shallow water or coastal) phytoplankton species (DTI, 2003). Diatoms of the genera *Chaetoceros* and *Thalassiosira*, in addition to dinoflagellates of the genus *Ceratium*, are the dominant phytoplankton taxa in this region of the North East Atlantic (Johns and Wooton, 2003).

Zooplankton is a primary food source for fish, seabirds and whales, such as humpback, right and fin whales (Reid *et al*., 2003; DECC, 2009). The zooplankton community in the Victory area includes the larval stages of fish (ichthyoplankton), larval decapods (crustaceans) and echinoderms, as well as copepods and krill (also crustaceans). Zooplankton exhibit a seasonal and geographical variation in abundance and distribution that is closely linked to the over-wintering of animals and food availability. Copepods are the main constituent of the zooplankton West of Shetland (Johns and Wooton, 2003). In addition, the oceanic calanoid copepod *Calanus finmarchicus* plays an important role in the Faroe-Shetland region, directly feeding pelagic fish stocks such as herring and mackerel (Melle *et al*., 2014).

4.3.2 Seabed Communities

The benthos refers to the animals (and plants where light levels are sufficient) that live on or within the seabed. Animal communities are divided at a basic level into infauna and epifauna. Infauna consists mainly of animals that burrow into the sediment or form tubes in it, generally representing the larger component of benthic communities. Those species which live on, as opposed to in, the seabed including those attached to rocks or other animals are known as epifauna.

Habitat Classification

Data from the EMODnet broad-scale seabed habitat map for Europe (EUSeaMap2), indicates that the proposed Victory development is located following European Nature Information System (EUNIS) habitat classifications: 'Offshore Circalittoral Sand (MD5, A5.27) at the Victory main location and along the proposed pipeline route to HTT2 and 'Deep-sea sand' (ME5, A6.3) or 'Deep-sea muddy sand' (ME4, A6.4), along the deeper section of the proposed umbilical route to Edradour (see Figure 4.7).

The habitat investigation undertaken at the Victory location used a combination of field observations and detailed review of video footage and still images to identify and map the habitat types.

SSS data showed variability across the survey area, ranging from sand ripples and megaripples predominantly on the main Victory site, to clear banding of coarse and finer sediment along the HTT2 route (BSL, 2021b).

Along the Edradour route, the habitat type 'Mixed Sediment Type with Striation Patterning' was delineated, characterised by striated bands of differing reflectivity following the depth contours at depths of approximately 190m to 300m. Due the irregular nature of the striations, it was not possible to delineate the habitat at the scale of each striation or band. This habitat type was comprised of sand, with varying contributions of gravel and cobbles and boulders. The habitat type was ground-truthed by all camera transects on the Edradour route, which indicated the high variability of this habitat type, displaying aspects of Offshore Circalittoral Coarse Sediment, Offshore Circalittoral Mixed Sediment and Offshore Circalittoral Sand (BSL, 2021b).

Based on the imagery data obtained along the Victory transects, three JNCC/EUNIS habitat classifications were assigned for the survey area (A5.27, A5.15 and A5.45; see Table 4.5), one of which (A5.27) is consistent with the predicted EUNIS classifications identified on Figure 4.7. The extent of these habitat types is mapped in Figure 4.8 to Figure 4.10 and a description of each one is provided below. Note, in order to remain consistent with the data from the Glenlivet Pipeline & Umbilical Route Surveys (Fugro, 2011), the mapped habitat nomenclature used in Figure 4.8 to Figure 4.10 have remained similar to those used in 2012.

The same three biotope types were recorded along the Glenlivet Route 2 survey, which crosses through the main Victory survey area. A5.27 (deep circalittoral sand) was evident along the majority of the route, A5.15 (deep circalittoral coarse sediment) was evident over the extensive megaripple field found in the main Victory survey area and A5.45 (deep circalittoral mixed sediments) was observed at sporadic locations, including a section at the end of Route 2, which is approximately 8 km east of the HTT2 tie-in location (Fugro, 2011).

Previous surveys at the Edradour drill centre (Fugro, 2012a) also show that the biotope complex A5.27 (deep circalittoral sand) is extensive in the area.

Surveys of the Glendronach area, immediately to the south of Edradour, and the Benriach area, to the north east of Edradour, were found to be dominated by coarse sands and gravel, with three biotopes recorded; A5.15 (deep circalittoral coarse sediment), A6.2 (deep-sea mixed substrata) and A6.3 (deep-sea sand) (MMT, 2019a and MMT, 2019b).

Coarse sublittoral mixed sediments (SS.SMx) were found in varying forms during the Yell Sound pipeline route survey, with uniform sandy gravel habitat recorded in the area of the HTT2 tie-in location (Fugro,, 2009a).

Table 4.5: Summarised Habitat Classifications (BSL, 2021b)

Victory Sediment Classification	JNCC Description	JNCC Classification	EUNIS Classification 2007	EUNIS Name 2007	EUNIS Classification 2019	EUNIS Name 2019
Gravelly Coarse Sand, Slightly Gravelly Coarse Sand, Gravelly Sand, Sandy Gravel	Offshore (deep) circalittoral habitats with coarse sands and gravel or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little quantitative data available. Such habitats are quite diverse compared to shallower versions of this habitat and generally characterised by robust infaunal polychaete and bivalve species. Animal communities in this habitat are closely related to those found in offshore mixed sediments.	SS.SCS.OCS	A5.15	Deep Circalittoral Coarse Sediment	MD3	Offshore Circalittoral Coarse Sediment
Coarse Sand, Sand Ripples, Sandwaves, Sandwaves with Gravelly Troughs	Offshore (deep) circalittoral habitats with fine sands or non-cohesive muddy sands. Very little data is available on these habitats however they are likely to be more stable than their shallower counterparts and characterised by a diverse range of polychaetes, amphipods, bivalves and echinoderms.	SS.SSa.Osa	A5.27	Deep Circalittoral Sand	MD5	Offshore Circalittoral Sand
Gravelly Sand, Sandy Gravel, Cobbles and Boulders	Offshore (deep) circalittoral habitats with slightly muddy mixed gravelly sand and stones or shell. This habitat may cover large areas of the offshore continental shelf although there is relatively little data available. Such habitats are often highly diverse with a high number of infaunal polychaete and bivalve species.	SS.SMx.Omx	A5.45	Deep Circalittoral Mixed Sediment	MD4	Offshore Circalittoral Mixed Sediment

Figure 4.7: Predicted Seabed Habitats in the Vicinity of the Victory Development

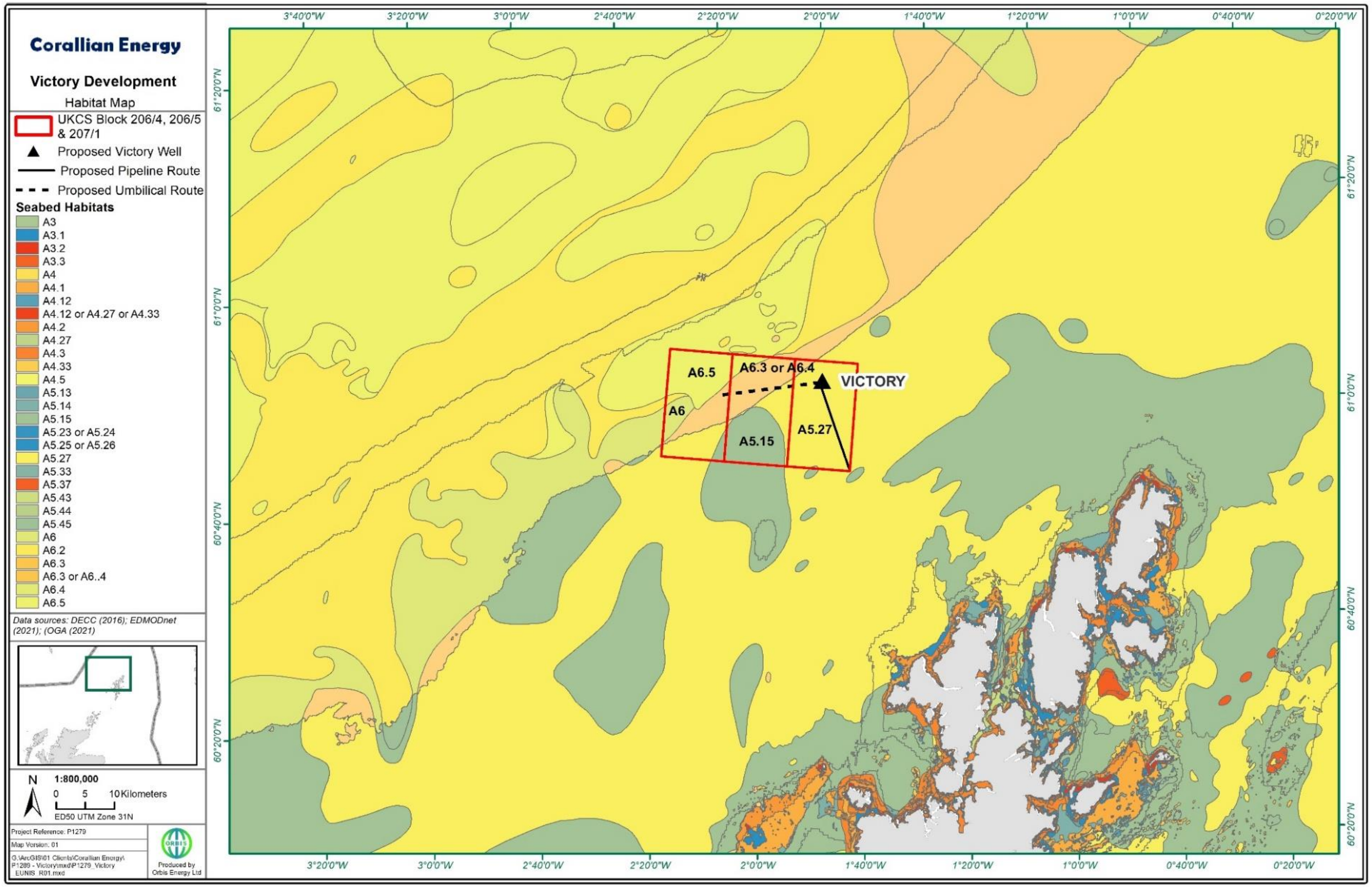


Figure 4.8: Habitat Distribution Over Sidescan Sonar Data for the Victory Gas Field Survey Area (BSL, 2021b)

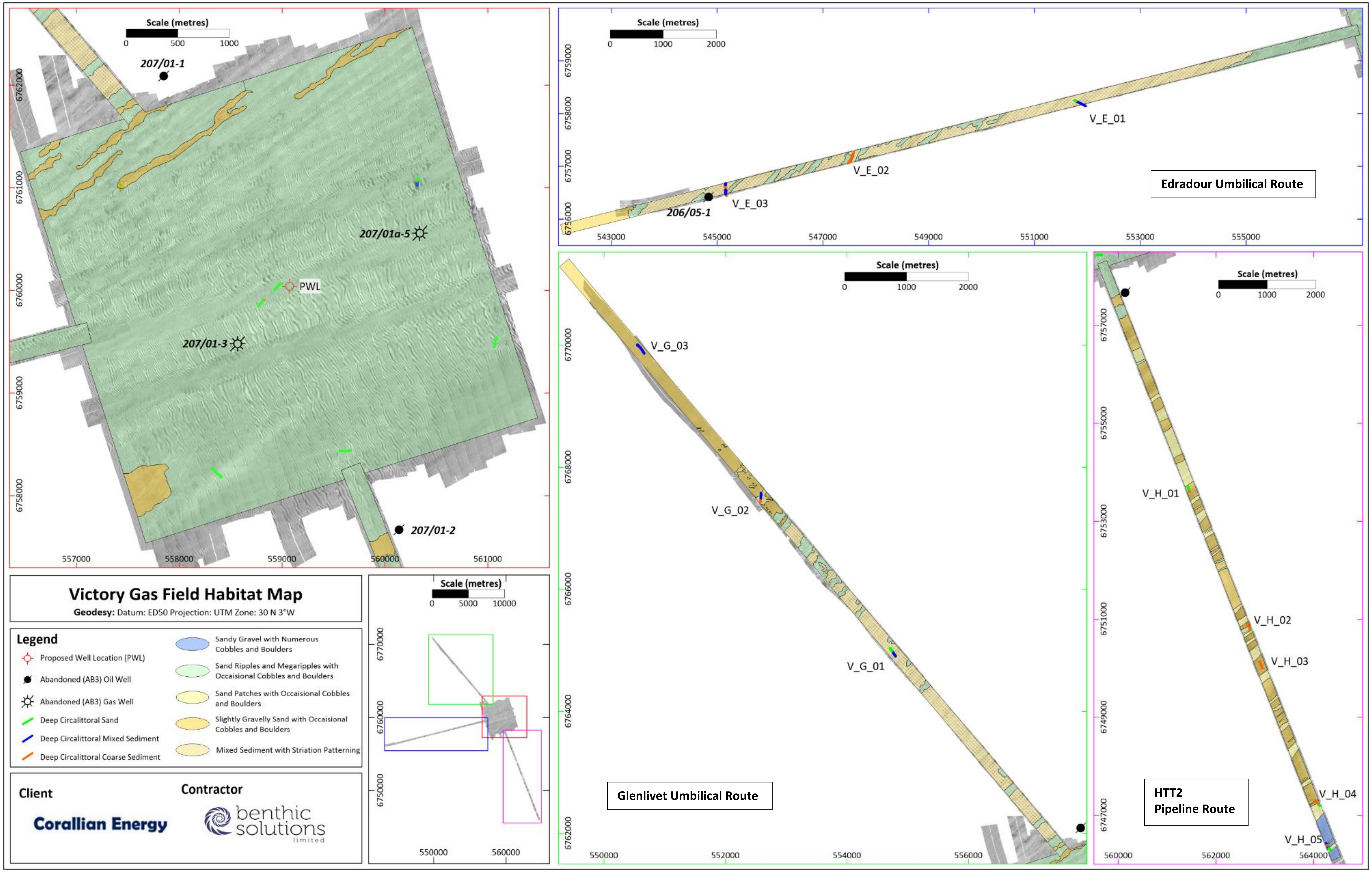


Figure 4.9: Zoomed in Habitat Distribution Over Sidescan Sonar Data Along the Pipeline Route to HTT2

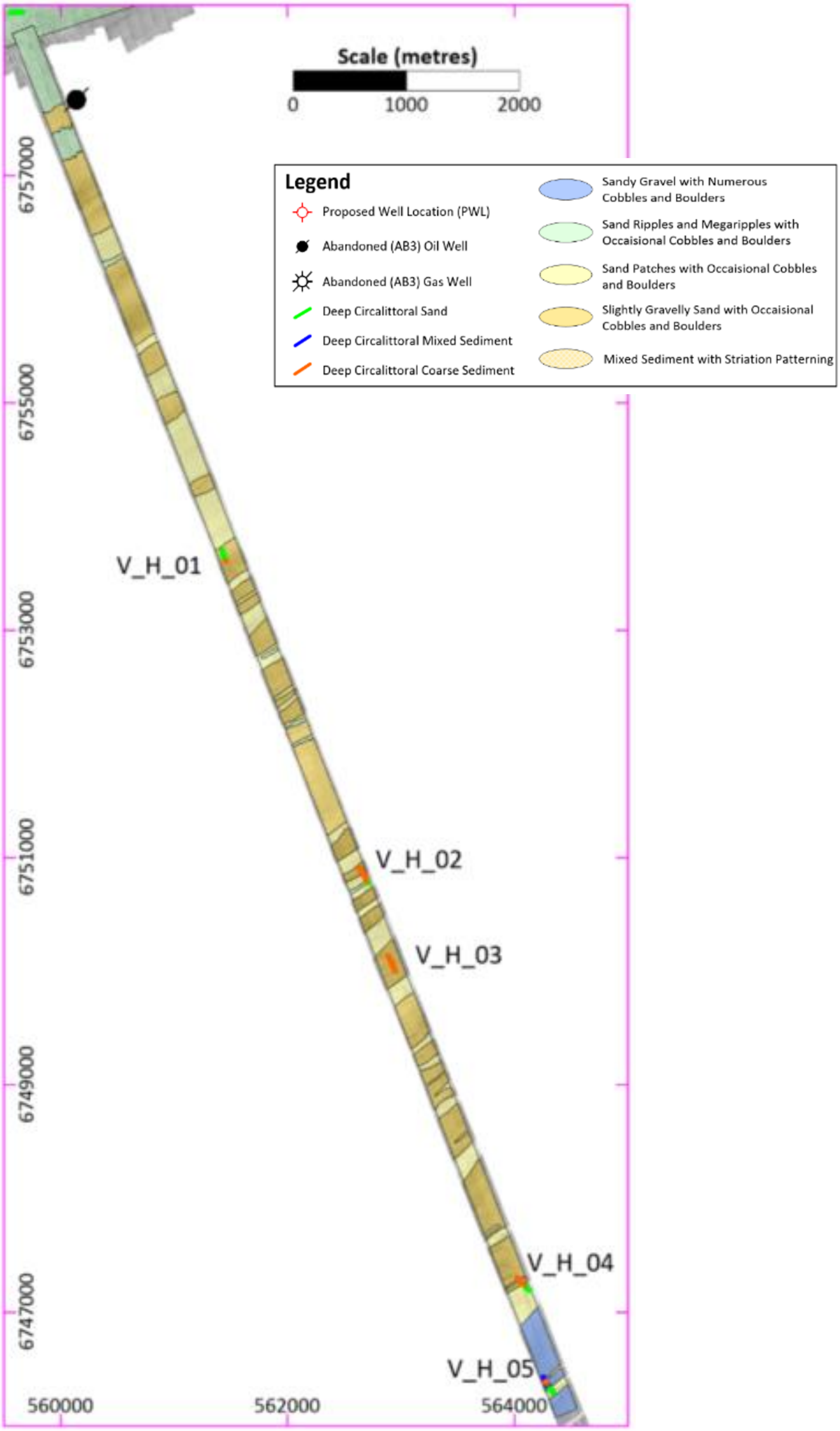
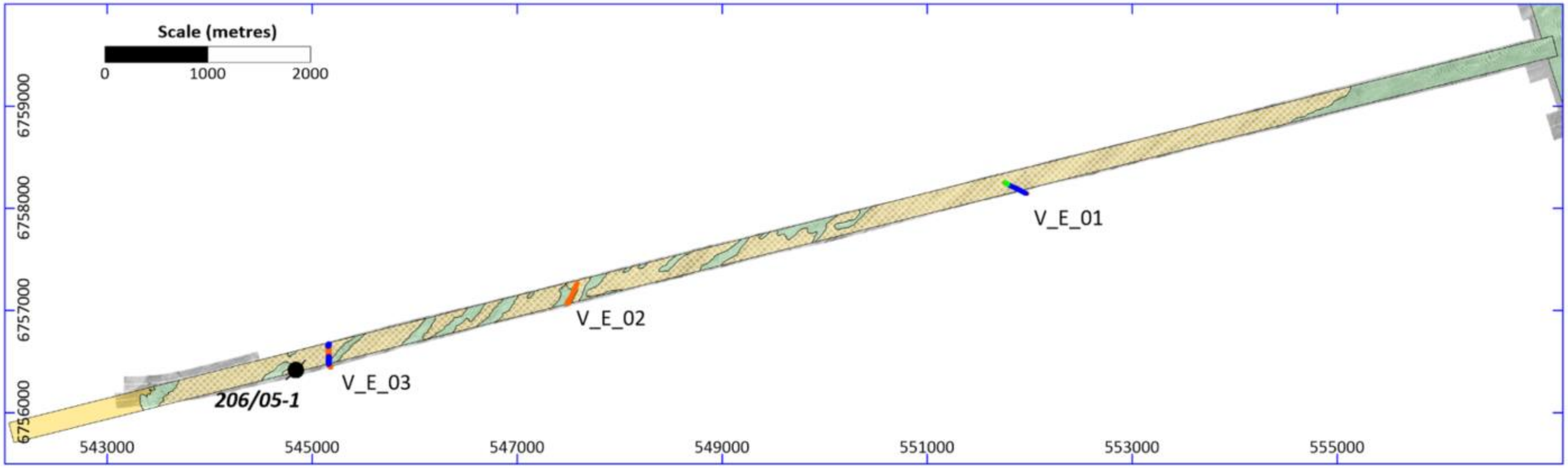
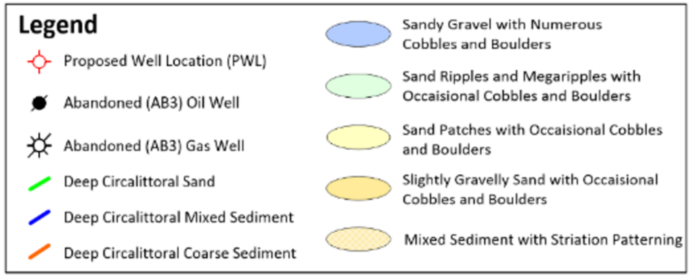


Figure 4.10: Zoomed in Habitat Distribution Over Sidescan Sonar Data Along the Umbilical Route from Victory to Edradour





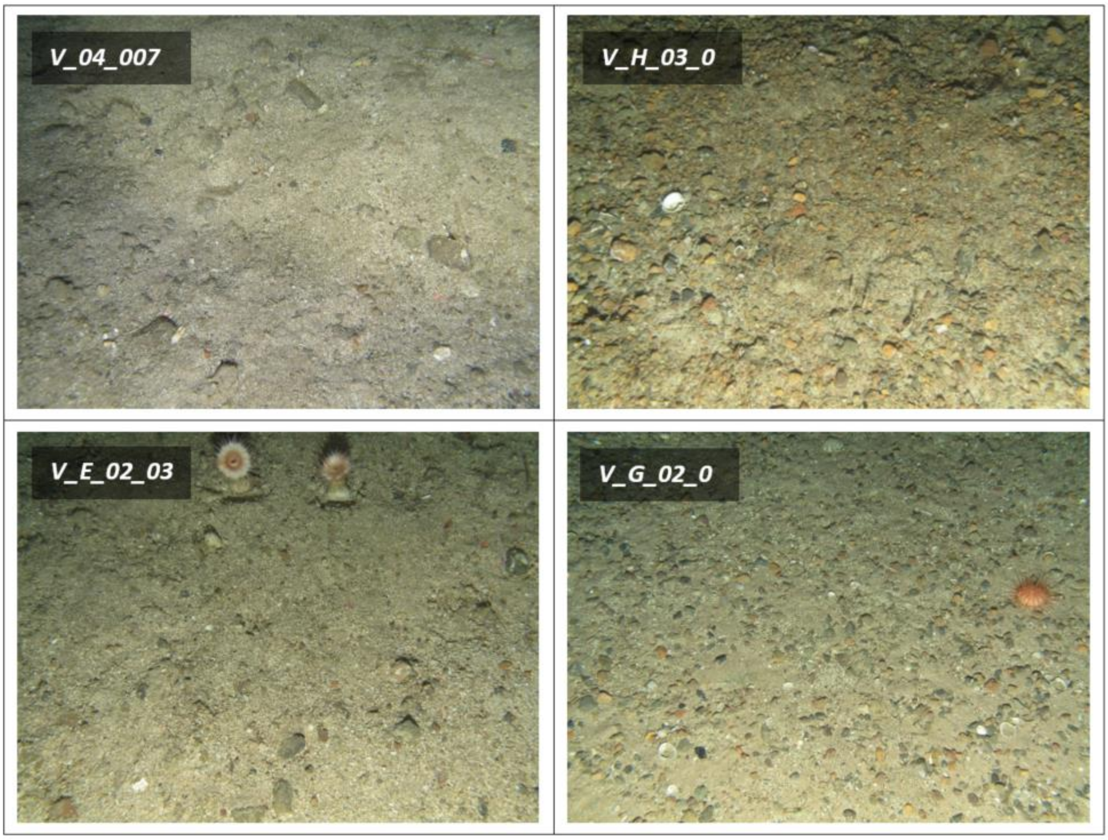
Offshore Circalittoral Coarse Sediment (MD3)

Habitats that comprised partly of coarse sand and shell or gravel were observed along 12 of the 18 the environmental camera transects within the Victory survey area. This sediment type falls under the EUNIS classification of MD3 'Offshore Circalittoral Coarse Sediment' (JNCC habitat SS.SCS.OCS 'Offshore Circalittoral Coarse Sediment'; JNCC, 2015).

Example seabed images of the MD3 'Offshore Circalittoral Coarse Sediment' habitat from the Victory survey are presented in Figure 4.11. This biotope is often more diverse than the shallower coarse sediment biotopes and is described as being characterised by infaunal polychaetes and bivalves (JNCC, 2015).

Fauna observed on the seabed photographs and video included a variety of mobile epifauna such as the starfish (*Porania pulvillus)*, *Stichastrella rosea, Asterias sp., Luidia sarsi,* brittle stars (Ophiuroidea) and the holothurian *Parastichopus tremulus* in the deepest parts of the survey area. Hermit crabs (Paguroidea), whelks (Buccinidae), teleost fish (Gobiidae, Pleuronectidae, Sebastes) and monkfish (*Lophius piscatorius*) were observed. Additionally, polychaetes including *Ditrupa* sp., the emergent infaunal sand mason polychaete *Lanice conchilega, Hyalinoecia tubicola* as well as *Hydroides elegans* and Serpulidae were seen. Occasional occurrences of bryozoans and hydroids were also observed on cobbles (BSL, 2021b).

Figure 4.11: Offshore Circalittoral Coarse Sediment (MD3) Habitat (BSL, 2021b)



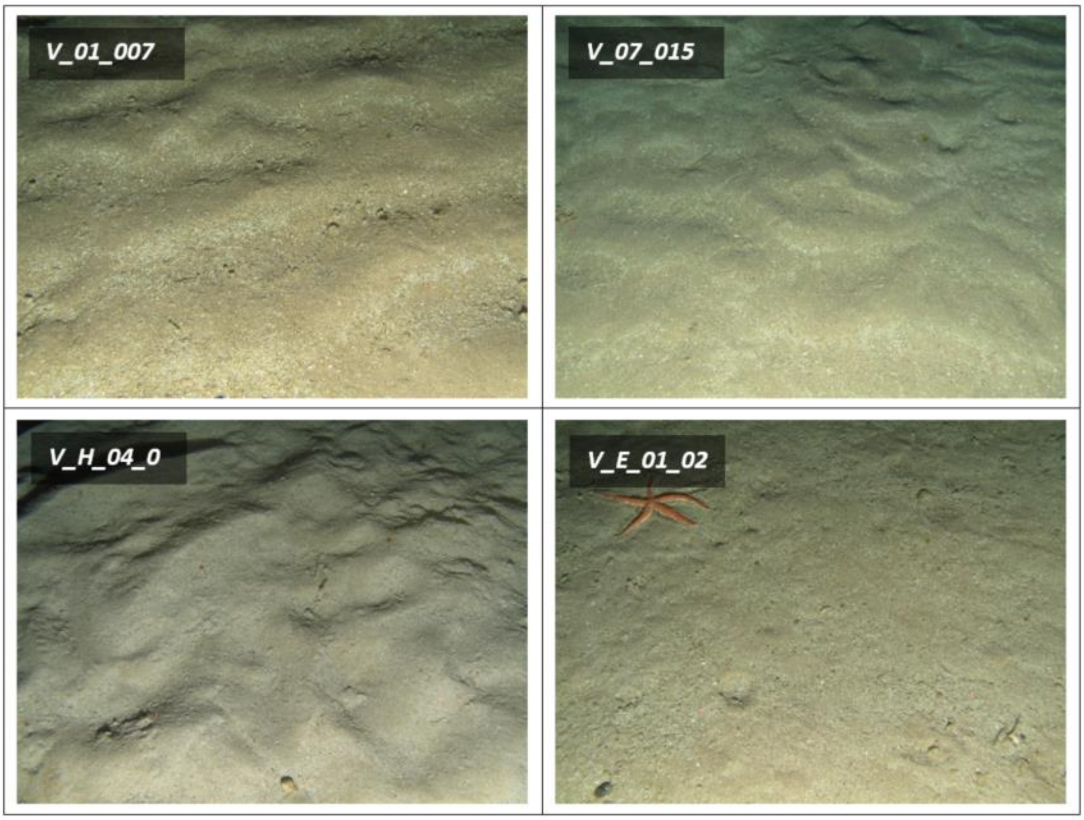
Offshore Circalittoral Sand (MD5)

Habitats dominated by sand were observed at 13 of the 18 camera transects, including all seven transects at the main Victory site. This sediment is classified as Offshore Circalittoral Sand' which corresponds to mapped areas of 'Sand Ripples and Megaripples with Occasional Cobbles and Boulders' and 'Sand Patches with Occasional Cobbles and Boulders'. and the habitat is characterised by a diverse range of polychaetes, amphipods, bivalves, and echinoderms. This biotope is the predicted habitat for Victory survey area as mapped by EMODnet.

Fauna observed within this habitat included Echinodermata (Asteroidea, Ophiuroidea, Spatangoida, *Porania pulvillus*), Arthropoda (Paguridae), and Mollusca (Buccinidae). During the visual survey of this habitat, fish were observed including gadoids, Limanda and Pleuronectiforms (BSL, 2021b).

Example seabed images for this habitat from the Victory survey are provided in Figure 4.12.

Figure 4.12: Offshore Circalittoral Sand (MD5) Habitat (BSL, 2021b)



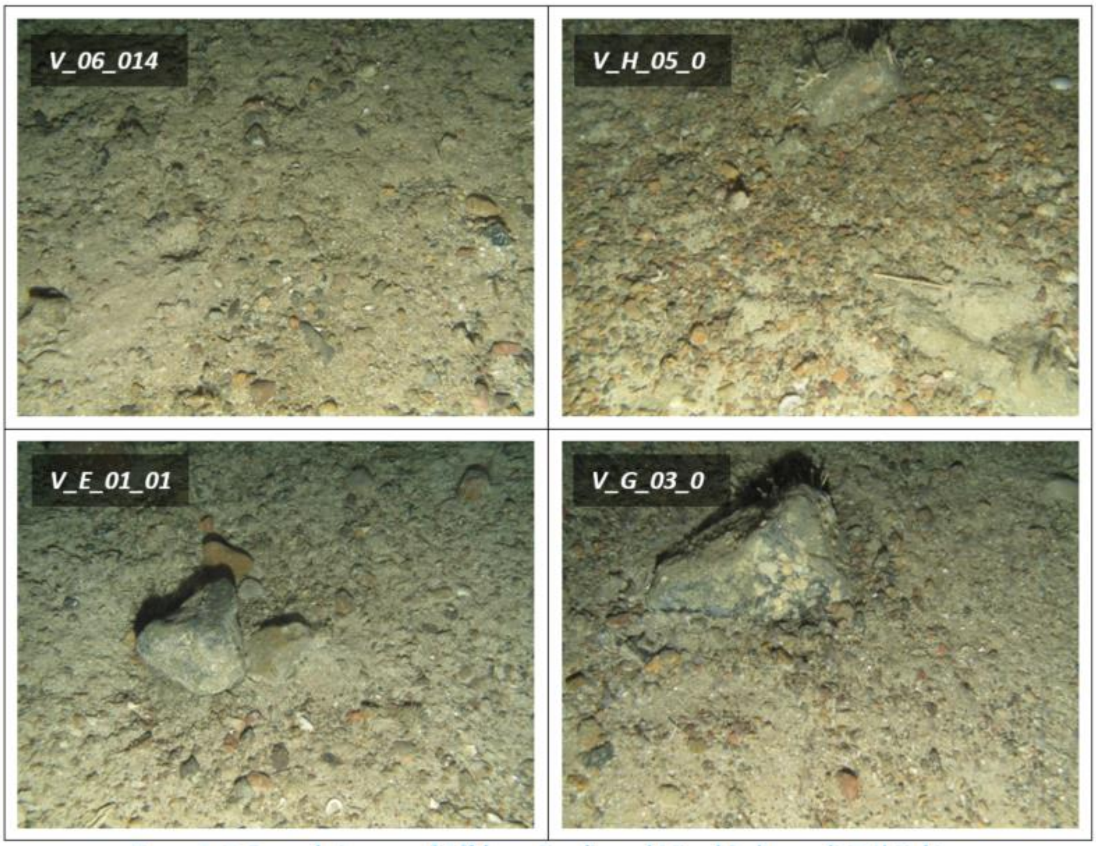
Offshore Circalittoral Mixed Sediment (MD4)

This habitat is characterised by higher proportions of gravel, cobbles, and boulders, and was observed at 7 of the 18 transects within the survey area. Offshore Circalittoral Mixed Sediment relates to mapped areas of ‘Sandy Gravel with Numerous Cobbles and Boulders’ and ‘Sand Patches with Occasional Cobbles and Boulders’.

Fauna observed within this habitat included increased prevalence of low-level encrusting fauna including bryozoan, hydroids and serpulid tubeworms (*Hydroides elegans*) and encrusting sponges (Porifera). Anemones were obsereved including *Actinauge sp*., *Strongylocentrotus sp*., the encrusting serpulid *Hydroides elegans* and the holothurian *Parastichopus tremulus.* Additionally mobile fauna including hermit crabs (Paguroidea), starfish (*Porania pulvillus*, *Anseropoda placenta*, *Stichastrella rosea*, and *Luidia sp.)* and fish (Molva*,* Pleuronectidae and Sebastes) were seen (BSL, 2021b).

Example seabed images for this habitat from the Victory survey are provided in Figure 4.13.

Figure 4.13: Offshore Circalittoral Mixed Sediment (MD4) Habitat (BSL, 2021b)



Potential Sensitive Habitats and Species

The following potential sensitive habitats and species are known to occur in the wider region (West of Shetland):

- Sub-tidal reefs (e.g. biogenic reefs formed by *D. pertusum* and rocky reefs formed from iceberg scour or moraine deposits);
- Ocean Quahog (*Arctica islandica*);
- Deep-sea Sponge Aggregations.

The Victory habitat investigation and environmental baseline survey paid particular attention to establishing whether or not any of the above habitats and/or species occurred within the survey area.

<u>Annex I Reef</u>

The Victory field is situated in an area identified as having the potential for 'stony reef' habitats (JNCC, 2021c; JNCC, 2016b). 'Stony reef' is listed as a protected habitat in Annex I of the EU Habitats Directive.

Stony reefs are defined by the Habitats Directive as comprising 'areas of boulders (>256mm diameter) or cobbles (64mm – 256mm diameter) which arise from the seafloor and provide suitable substratum for the attachment of algae and/or animal species' (Irving, 2009). Although no iceberg scourmarks were identified within the Victory survey area, cobbles and boulders were encountered along the majority of the video transects. The seabed camera ground-truthing data were therefore assessed for potential stony reefs using the criteria proposed by Irving (2009).

For this assessment, the Irving (2009) stony reef protocol was split into separate assessments of reef 'structure' and 'overall reefiness' using a method developed by BSL staff (Table 4.6 and Table 4.7). This provided a reef structure value that could then be assessed against extent, where applicable, to provide a measure of overall reefiness.

As separate thresholds for 'Low', 'Medium' and 'High' stony reef extent are not given in Irving (2009), the overall reefiness is determined by reef structure provided that the extent of the stony reef covers a minimum of 25m². For this survey, as the cover of cobbles and boulders was highly variable within areas of similar acoustic facies, assessment of extent at the seabed was based on the swept area of the camera transect.

Table 4.6: Stony Reef Structure Matrix (after Irving, 2009)

Reef Structure Matrix			Elevation			
			Flat	<64mm	64mm-5m	>5m
			Not a Reef	Low	Medium	High
Composition	<10%	Not a reef	Not a Reef	Not a Reef	Not a Reef	Not a Reef
	10-40%	Low	Not a Reef	Low	Low	Low
	40-95%	Medium	Not a Reef	Low	Medium	Medium
	>95%	High	Not a Reef	Low	Medium	High

Table 4.7: Overall Stony Reefiness Matrix (Structure vs Extent)

Overall Reefiness Matrix			Reef Structure (incl. Composition and Elevation)			
			Not a Reef	Low	Medium	High
Extent (m²)	<25	Not a Reef	Not a Reef	Not a Reef	Not a Reef	Not a Reef
	>25	Low - High	Not a Reef	Low	Medium	High

The results of the assessment are detailed in Table 4.8. In summary, the analysis of the stony reef video data confirmed the presence of cobbles and boulders along all eleven of the camera transects. However, this accounted for less than 10% of the seabed cover. On the whole, epifaunal coverage was low across the survey area and was generally limited to encrusting species such as sponges (Porifera), Bryozoa and tube-building polychaetes (Serpulidae). Some erect fauna were observed in the form of Hydrozoa and sea anemones (*Actinauge sp.*).

None of the transects showed any characteristics of 'medium' reef (BSL, 2021b).

All five of the camera transects over the main Victory site concluded the sediment was 'not a reef' as the cobbles and boulders present did not meet the minimum threshold for cover (10%), the seabed was classified as megarippled sandy seabed at these stations (BSL, 2021b).

Seven sections of seabed along six transects met the 'low' reefiness threshold for elevation (>64mm), but they were not considered reef as they show insufficient cobble and boulder cover (<10%). Five sections of seabed along three camera transects showed sufficient cover and elevation to meet the 'low' reefiness threshold for both of these measures, however only one section of seabed covered sufficient area (>25m²) to be classified as 'low' overall reefiness. This transect (Transect V_H_05) was located at the southern end of the HTT2 route in an area classified as 'Sandy Gravel with Numerous Cobbles and Boulders' (see Figure 4.8) but 'low' reef was not evident throughout this habitat (BSL, 2021b). SSS and MBES data examples for transects V_H_05 are displayed in Figure 4.14. Example seabed images from Transect V_H_05 are provided in Figure 4.15.

Subtidal rocky reefs were also identified along the offshore section of the Yell Sound pipeline route, occurring sporadically from KP53, which is located west of the HTT2 tie-in location (i.e. further offshore) (Fugro, 2009a).

Along the Glenlivet Route 2 corridor, stony substrate was generally limited to the areas delineated as 'sandy gravel with numerous cobbles and boulders' which were found sporadically across the entire survey area, but considerably more concentrated between KP4.030 to KP14.637 (to the north west of the main Victory area) and KP31.00 and KP37.792, to the east of the HTT2 tie-in location. When assessed using the stony reef assessment criteria, the areas were thought to be of low potential as stony reef, as they were scored 'low reefiness' in each of the other assessment criteria (i.e. less than 64 mm elevation above the surrounding sediment and between 10% to 40% cover of visible epifauna). (Fugro, 2011).

The Edradour Development Area has also been subject to a stony reef assessment. All but one of the stations sampled had low potential for qualifying as stony reef in terms of cobble and boulder composition; elevation above the surrounding seabed; and extent of cover by colonising species (Fugro, 2012a, 2012b). The one remaining station, located in the deeper half of the umbilical route, away from the Victory area, was classed as having moderate 'reefiness'. This assessment work suggests that whilst the Edradour area may host rock habitats and associated fauna, the extent of any such habitat is extremely restricted and the seabed on which the development will be located does not comprise high quality rocky reef habitat (Total, 2012). More recent survey work at Glendronach and Benriach, in the vicinity of the Edradour manifold, found no stony reef habitat to be present (MMT, 2019a and MMT, 2019b).

The Victory field also falls within the theoretical range of the cold water coral *L. pertusa*. *L. pertusa* is known for its potential to form biogenic reef features, and has been encountered at numerous locations and water depths in the wider north east Atlantic region. The conservation importance of *L. pertusa* reefs is increasingly recognised, not only because of their longevity and high biodiversity, but also due to potential benefits for commercial fisheries (JNCC, 2008b). Examples of *L. pertusa* have also been found in association with the ridges formed by iceberg ploughmarks (JNCC, 2008b). However, no *L. pertusum* was observed within the Victory survey area. This is likely a result of the lack of significant hard substrate in the form of stony reef (BSL, 2021b). Historic surveys in the wider area, including the Yell Sound pipeline survey and the Glenlivet Route 2 survey also found no colonies (living or dead) of *L. pertusa* (Fugro, 2009a and Fugro, 2011).

Notwithstanding the above, Corallian commit to acquire further environmental data along the chosen pipeline and umbilical routes, as required, during the detailed engineering surveys scheduled to be undertaken in 2023, to reconfirm the absence of Annex I reef.

Table 4.8: Summary of Stony Reef Assessment (after Irving, 2009)

Geodetics: ED50 UTM 30N 3°W											Visible Epifauna
						Stony Reefiness (After Irving 2009)					
Station[1]	Easting (m)	Northing (m)	Length (m)	Date	Time (Local)	Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders)	Reef Structure	Extent on Video	Overall Reefiness Matrix	
V_04	557 531	6 760 992	33	20/06/21	00:38:53	<10%	<64mm	Not a Reef	NA	Not a Reef	*Lanice conchilega, Hyalinoecia tubicola, Ophiura sp.,* Spatangoida, Paguridae, *Porania pulvillus, Hydroides elegans*
	557 528	6 760 959		20/06/21	00:41:13						
V_06	560 412	6 761 056	44	20/06/21	03:31:51	<10%	<64mm	Not a Reef	NA	Not a Reef	Caridea, *Lanice conchilega*, Ophiuroidea, *Actinauge* sp., *Porania pulvillus, Echinus* sp., Serpulidae, Buccinidae, *Hydroides elegans*
	560 414	6 761 012		20/06/21	03:35:31						
V_H_03	563 045	6 749 988	153	21/06/21	03:11:47	<10%	<64mm	Not a Reef	NA	Not a Reef	*Lanice conchilega*, Serpulidae, *Porania pulvillus*, Bryozoa, *Alcyonium digitatum*, Buccinidae, Actinopterygii, Ophiuroidea, *Luidia sarsi, Hydroides elegans*, Echinoidea, Paguridae, Actiniaria, Hydroid, Actiniidae, *Stichastrella rosea, Lophius piscatorius, Munida* sp., *Pagurus* sp., Pleuronectiform, *Asterias* sp.
	562 990	6 750 131		21/06/21	03:23:53						
V_H_04	564 186	6 747 230	51	21/06/21	01:58:42	<10%	<64mm	Not a Reef	NA	Not a Reef	*Pagurus* sp., Serpulidae, *Hyalinoecia tubicola*, Bryozoa, *Lanice conchilega, Macropodia* sp., *Hydroides elegans, Asterias* sp., *Luidia sarsi, Porania pulvillus, Luidia ciliaris*
	564 149	6 747 265		21/06/21	02:01:27						
	564 135	6 747 281	18	21/06/21	02:02:44	<10%	<64mm	Not a Reef	NA	Not a Reef	*Hyalinoecia tubicola*, Paguridae, Gobiidae, *Porania pulvillus*, *Lanice conchilega, Stichastrella rosea*
	564 124	6 747 294		21/06/21	02:03:58						
V_H_05	564 413	6 746 317	55	21/06/21	01:02:31	10-40%	64mm-5m	Low	>25m^2	Low	*Lanice conchilega, Porania pulvillus, Hydroides elegans*, Paguridae, Juv. Gadoid, *Molva molva, Echinus* sp., Buccinidae, Bryozoa, Hydroids, Serpulidae, Ophiuroidea
	564 384	6 746 363		21/06/21	01:06:11						
	564 384	6 746 363	20	21/06/21	01:06:11	<10%	64mm-5m	Not a Reef	NA	Not a Reef	*Ditrupa* sp., Sebastes, Serpulidae, Hydroids, Paguridae, *Porania pulvillus, Hyalinoecia tubicola*, Actiniaria, *Lanice conchilega*
	564 376	6 746 381		21/06/21	01:07:26						
	564 376	6 746 381	17	21/06/21	01:07:26	10-40%	64mm-5m	Low	<25m^2	Not a Reef	Sebastes, Bryozoa, Hydroids, Paguridae, Juv. Gadoid, *Hyalinoecia tubicola, Lanice conchilega*
	564 368	6 746 396		21/06/21	01:08:31						
	564 368	6 746 396	20	21/06/21	01:08:31	<10%	64mm-5m	Not a Reef	NA	Not a Reef	*Luidia ciliaris, Anseropoda placenta, Hyalinoecia tubicola*, Bryozoa, Hydroids, *Lanice conchilega*
	564 358	6 746 414		21/06/21	01:09:52						
	564 358	6 746 414	3	21/06/21	01:09:52	10-40%	64mm-5m	Low	<25m^2	Not a Reef	*Hyalinoecia tubicola, Lanice conchilega*, Bryozoa, Hydroids, *Porania pulvillus*
	564 356	6 746 416		21/06/21	01:10:05						

Geodetics: ED50 UTM 30N 3°W											Visible Epifauna
						Stony Reefiness (After Irving 2009)					
Station[1]	Easting (m)	Northing (m)	Length (m)	Date	Time (Local)	Composition (% cover of cobbles/ boulders)	Elevation (of cobbles/ boulders)	Reef Structure	Extent on Video	Overall Reefiness Matrix	
V_E_01	552 063	6 758 132	180	22/06/21	04:00:02	<10%	64mm-5m	Not a Reef	NA	Not a Reef	*Pagurus* sp., *Porania pulvillus, Anseropoda placenta, Ditrupa* sp., *Munida* sp., Buccinidae, Paguridae, Ophiuroidea, *Stichastrella rosea*, *Luidia sarsi*, Anthozoa, *Hydroides elegans*, Sebastes, *Ophiura* sp., *Actinauge* sp.
	551 903	6 758 215		22/06/21	04:12:43						
V_E_02	547 599	6 757 081	229	22/06/21	02:39:15	<10%	<64mm	Not a Reef	NA	Not a Reef	*Porania pulvillus*, Caridea, Spatangoida, *Stichastrella rosea*, Sebastes, Asteroidea, *Actinauge* sp., Ceriantharia, *Cerianthus lloydi*, Actiniidae, Paguridae, *Pagurus* sp., *Ditrupa* sp., Hydroids, *Parastichopus tremulus*, Buccinidae, *Lanice conchilega*, *Ophiura* sp.
	547 714	6 757 278		22/06/21	02:56:56						
V_E_03	545 261	6 756 467	65	21/06/21	22:26:04	<10%	64mm-5m	Not a Reef	NA	Not a Reef	*Porania pulvillus*, Caridea, *Actinauge* sp., *Ditrupa* sp., Sebastes, *Hyalinoecia tubicola, Stichastrella rosea, Parastichopus tremulus*, *Munida* sp., Sepiidae
	545 262	6 756 532		21/06/21	22:30:04						
	545 257	6 756 643	13	21/06/21	22:37:56	10-40%	64mm-5m	Low	<25m²	Not a Reef	Caridea, *Actinauge* sp.
	545 262	6 756 655		21/06/21	22:38:36						
V_G_01	554 844	6 764 977	103	23/06/21	07:05:19	<10%	64mm-5m	Not a Reef	NA	Not a Reef	*Actinauge* sp., *Ditrupa* sp., *Porania pulvillus, Munida* sp., *Stichastrella rosea, Ophiura* sp., Pleuronectiform, Sebastes, Actiniidae, Buccinidae, *Parastichopus tremulus, Hyalinoecia tubicola*
	554 899	6 764 891		23/06/21	07:12:10						
V_G_02	552 683	6 767 564	58	23/06/21	11:30:29	<10%	64mm-5m	Not a Reef	NA	Not a Reef	*Stichastrella rosea*, Paguridae, *Strongylocentrotus* sp., Holothurian, *Molva molva*, Sebastes, *Parastichopus tremulus, Cidaris* sp., *Munida* sp., *Ditrupa* sp.
	552 686	6 767 506		23/06/21	11:35:40						
	552 684	6 767 494	17	23/06/21	11:36:32	10-40%	64mm-5m	Low	<25m²	Not a Reef	*Strongylocentrotus* sp., *Cidaris* sp., *Ditrupa* sp., *Munida* sp., *Stichastrella rosea, Actinauge* sp., Buccinidae
	552 682	6 767 477		23/06/21	11:37:50						
V_G_03	550 651	6 769 990	180	23/06/21	12:46:28	<10%	64mm-5m	Not a Reef	NA	Not a Reef	Anthozoa, Buccinidae, *Cidaris* sp., Caridea, *Hyalinoecia tubicola*, *Ditrupa* sp. *Hydroides elegans, Parastichopus tremulus, Strongylocentrotus* sp., *Stichastrella rosea, Porania pulvillus, Molva molva, Munida* sp., Paguridae, Sebastes, Encrusting Porifera
	550 764	6 769 850		23/06/21	13:02:33						

[1] At each station, transects were subdivided according to obvious changes in density, height and cover of cobbles and boulders.

Figure 4.14: SSS and MBES Data Examples at Transect V_H_05

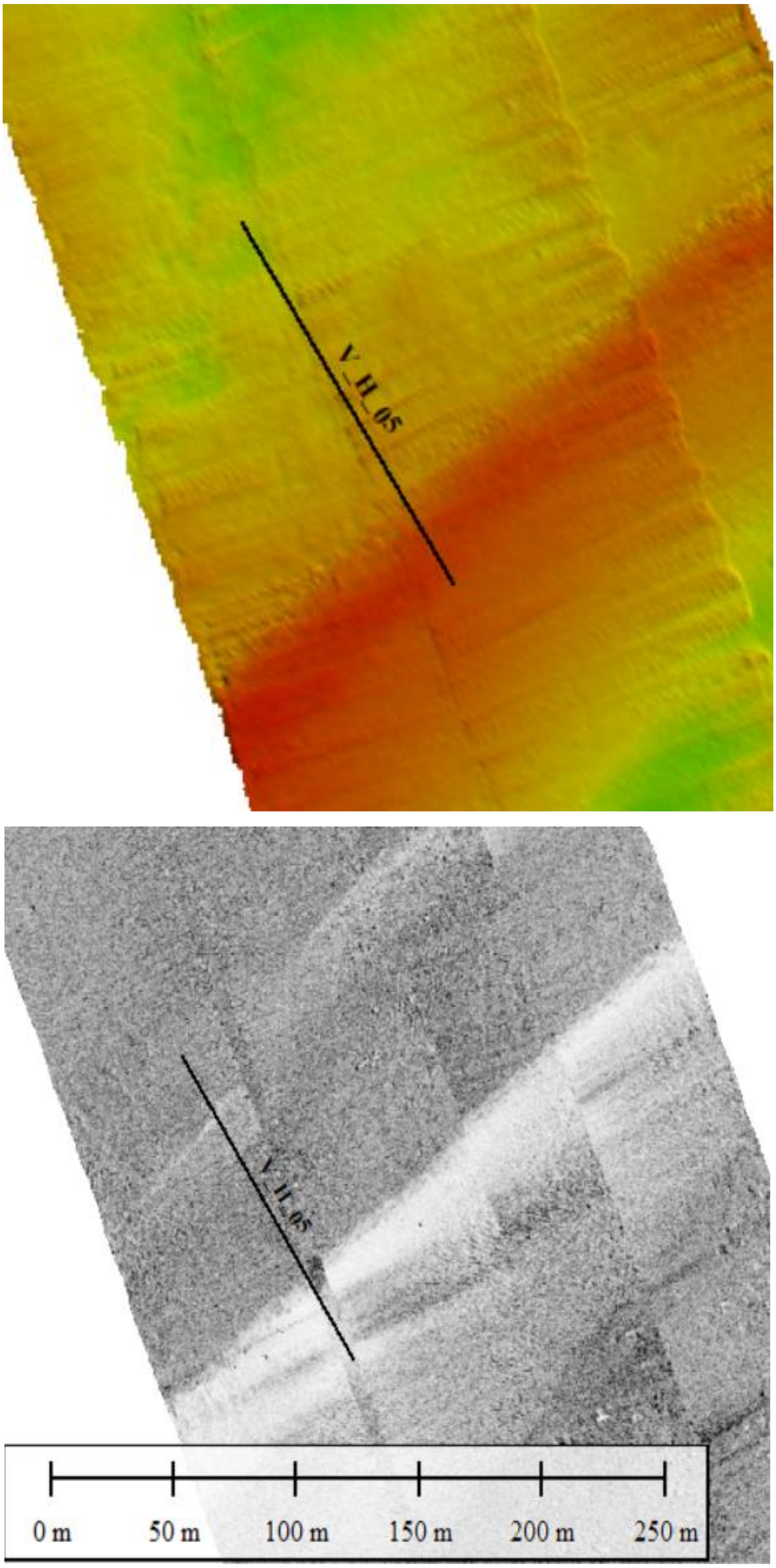
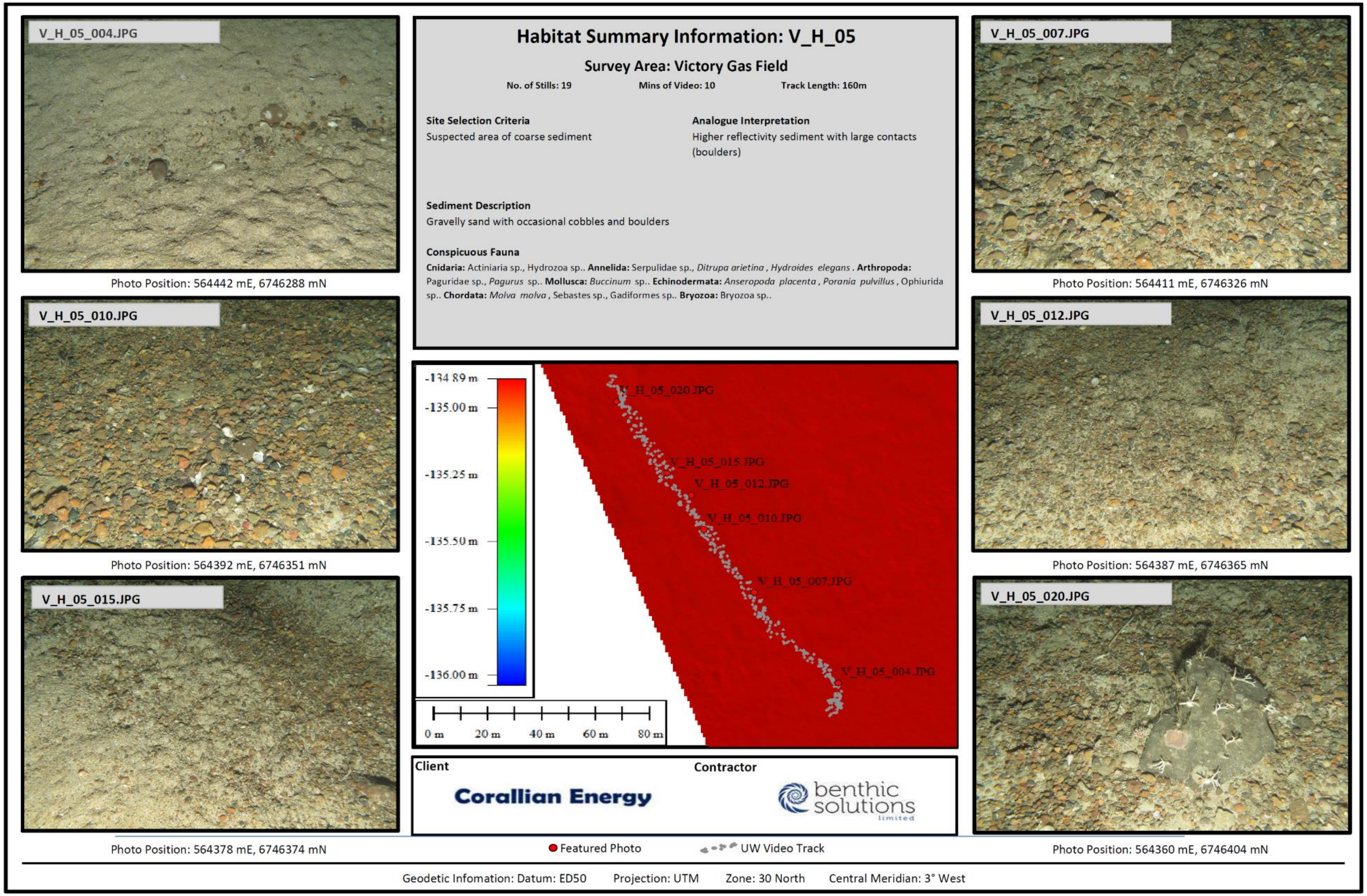


Figure 4.15: Example Seabed Photographs at V_H_05 (BSL, 2021b)



Ocean Quahog (*Arctica islandica*)

The ocean quahog (*Arctica islandica*) bivalve species is afforded protected status under the OSPAR Commission due to its inclusion on the OSPAR list of threatened and/or declining species in the Greater North Sea area as a priority species (OSPAR, 2008; 2009a). This species is also listed as a Marine Conservation Zone (MCZ) Features of Conservation Importance (FOCI) for both inshore and offshore protection (JNCC and Natural England, 2016). Ocean quahog grow very slowly, and are at particular risk from bottom fishing gear, and, like other slow-growing animals, once their numbers have been reduced their populations can take a long time to recover.

Ocean quahog is recorded as inhabiting the Faroe-Shetland Sponge belt, West of Shetland; however, no individuals were recorded in the macrofauna data at Victory, no potential relict shells were observed along the video transects and no live individuals or their distinctive siphons were noted during analysis of video footage and still photographs from the survey area (BSL, 2021a & BSL, 2021b).

However, it is acknowledged that the species has previously been recorded in the area, with juveniles of *Arctica islandica* detected in three grab samples from the Glendronach survey, south of the Edradour manifold, with a total of four individuals recorded (MMT, 2019b). It is therefore possible that *Arctica islandica* could be present within the Victory development area.

Deep-sea Sponge Aggregations

Deep sea sponge aggregations are recorded from the northern Scottish slope of the Faroe-Shetland Channel (OSPAR, 2010). Although they are usually found in water depths greater than 250 m, significant sponge aggregations can be found as shallow as 30m, and therefore the Victory field location has the potential to host sponge aggregations.

The presence of the Faroe-Shetland Sponge Belt MPA, located approximately 8 km to the northwest of the Victory proposed well location (refer to Section 4.3.6), increases the likelihood for sponge aggregations to occur. The Faroe-Shetland Sponge Belt MPA is characterised by iceberg scars in the seabed caused by the scouring action of icebergs during past ice ages. Over time these scars have been partially filled with sediments, creating a mosaic of habitats that can host sponge aggregations (JNCC, 2018).

The majority of sponges observed within the Victory survey area were encrusting sponges attached to cobbles and boulders. Only two instances of non-encrusting sponges were observed throughout the survey area, deemed not significant enough to be classified as a deep-sea sponge aggregation. In addition, no iceberg scours were evident in the Victory survey area from the SSS and bathymetry data (BSL, 2021b).

The Glenlivet Route 2 survey also concluded that the sponge fauna associated with areas of 'sandy gravel with numerous cobbles and boulders' was not sufficiently dense or diverse enough to be classified as OSPAR Deep-sea sponge aggregations habitat (Fugro, 2011).

No areas were classified as OSPAR "Deep-sea sponge aggregations" during the Benriach survey (MMT, 2019a); however, a potential area of deep-sea sponge aggregations was found in the north western parts of the Glendronach survey area, to the south of Edradour. In this area, sponge densities fulfilled the density criteria for deep-sea sponge aggregations and were also assessed to make up most of the biomass, also a criterion for deep-sea sponge aggregations. However, the sponges had limited fauna associated with them (MMT, 2019b).

Away from the Victory area, the biotope complex 'Deep sea sponge aggregations' was identified along the proposed umbilical route from Edradour to Laggan, but in deeper water towards the Laggan end of the route (Total, 2012).

Benthic Infaunal Communities

The proposed Victory development area showed a generally high species richness throughout the surveyed area, with similar species dominating throughout. Macrofaunal analysis was carried out on 20 grab samples obtained at ten environmental stations within the Victory survey area (see Table 4.1 in Section 4.1).

A total of 2,846 individuals (infauna and solitary epifauna) from the samples were analysed. Overall, 186 taxa were recorded, of these nine belonged to the solitary epifauna category (specimens which are epifaunal in nature but recorded in low counts) and 117 were infaunal. The infaunal taxa consisted of 88 annelid species, which dominated the community, accounting for 40.2% of the total individuals. There were 45 species of crustaceans recorded (11.3% of the total individuals), 29 species of molluscs (4.6% of the total individuals), and seven species of echnioderns (5.8% of total individuals). Of the solitary epifauna observed, six memebers were Cnidaria, there were two members of Arthropoda and one Porifera taxa (*Sycon ciliatum*), accounting for 22.3% of total individuals. The other groups Nemertea, Nematoda, Sipuncula and Phoronida) were represented by eight species, accounting for 15.8% of the total individuals. The most abundant taxa from the Victory survey are listed in Table 4.9 (BSL, 2021a).

Table 4.9: Summary of Macrofaunal Analysis for the Victory Site Surveys (BSL, 2021a)

Phylum	Victory Survey [1]			
	Number of Taxa	**Total Taxa (%)**	**Abundance**	**Total Abundance (%)**
Annelida	88	47	1,144	40.2
Solitary epifauna (cnidarian, arthropoda, porifer)	9	5	635	22.3
Crustacea	45	24	322	11.3
Mollusca	29	16	131	4.6
Echinodermata	7	4	165	5.8
Other[2]	8	4	449	15.8
Total	**186**	**100**	**2,846**	**100**

[1] Victory survey sampled using a 0.5 millimetre mesh sieve;
[2] Other groups included Nemertea, Nematoda, Sipuncula and Phoronida

The species identified during the Victory survey were ranked in terms of dominance, ranking the taxa has made it possible to examine which were consistently dominant throughout the survey area. Annelids dominated within the infaunal community, making up five of the top ten ranked species. The most abundant species was the polychaete *Owenia,* with 489 individuals identified across all ten of the sampled Victory stations. The second and third most dominant taxa were the Cnidarian *Cerianthus lloydii* and Nematoda, with 572 and 359 individuals identified across 9 and 10 of the stations respectively. The Echnioderm *Echinocyamus pusillus* was the fourth most dominant species with a total abundance of 151 individuals, with occurrences at every station. The polychaete *Aonides paucibranchiata* completes the top five most dominant taxa with an abundance of 75 individuals.

Table 4.10 lists the rank dominance of taxa recorded during the Victory survey. The top ten taxa per station were ranked according to abundance, with a score of ten for the most abundant taxa decreasing to one for the least, these scores were summed for all 20 samples to provide an overall rank dominance score (Eleftheriou and Basford, 1989) for each taxon. The pattern of rank abundance and rank dominance were relatively consistent in the survey suggesting that the majority of the macrofaunal community structure was similar across the survey area, with only subtle differences in abundance of certain taxa observed throughout the site (BSL, 2021b).

Table 4.10: Overall Taxon Dominance Ranking (Top 15 Taxa) (BSL, 2021b)

Species / Taxon	Phylum	Victory Survey [1]			
		Rank Dominance	Total Dominance Rank Score (out of 200)	Numerical Abundance (10 pairs of replicates)	Rank abundance
Owenia	Annelida	1	156	489	2
Cerianthus lloydii	Cnidaria	2	153	572	1
Nematoda	Nematoda	3	132	359	3
Echinocyamus pusillus	Echinodermata	4	104	151	4
Aonides paucibranchiata	Annelida	5	67	75	6
Spiophanes wigleyi	Annelida	6	64	92	5
Tanaissus danica	Arthropoda	7	59	60	8
Pisione remota	Annelida	8	43	67	7
Notomastus	Annelida	9	38	44	10
Unciola planipes	Arthropoda	10	33	46	9
Nemertea	Nemertea	11	26	32	11
Spio symphyta	Annelida	12	25	27	12
Golfingia (Golfingia) vulgaris	Sipuncula	13	17	22	14
Asbjornsenia pygmaea	Mollusca	14	16	20	15
Caryophyllia (Caryophyllia) smithii	Cnidaria	15	15	25	13

[1]Victory survey sampled using a 0.5 millimetre mesh sieve

Primary and Univariate Analysis

Overall, the number of species identified during the survey was relatively consistent throughout the Victory survey area, there was limited variation in the number of species per station, with numbers ranging from 36 to 70 species. The number of individuals was slightly more variable, with numbers ranging from 155 to 362 across the stations. The variation in number of individuals and species across the Victory survey area was likely to be influenced by slight variations in sediment composition, however, there were no significant Spearman's correlations observed between the number of species of individuals and the proportion of fines, sand or gravel. This is likely to be explained by the high heterogeneity of the sediments across the stations and the lack of clear gradient of change in sediment type across the survey area (BSL, 2021b).

Diversity indices additionally showed less variations within the survey area, with values very similar value across stations, this reflects an equitable community consistent with the uncontaminated sandy sediments within the survey area. Additionally, evenness values, a diversity index measuring how close in numbers each species in an area are, are between 0-1 with values closer to one demonstrating less variation in communities between species (BSL, 2021b).

Multivariate Analysis

For the Victory survey stations, similarity profile (SIMPROF) analysis, which analyses the contribution of each species to the observed similarity between samples, identified four main clusters which were significantly different. As with univariate analysis, multivariate analysis of sample data indicates that there was small-scale variability in seabed sediment and macrofauna community composition. Cluster A was characterised by high univariate faunal parameter, Cluster B and Cluster D each included 40% of the stations sampled, suggesting a degree of homogeneity within some of the survey area, Cluster C was characterised by a low species richness. The top five taxa (in order of abundance) characterising these clusters are as follows:

- Cluster A – *Owenia, Cerianthus lloydii, Echinocyamus pusillus, Aonides paucibranchiata, Spiophanes wigleyi*;
- Cluster B – *Cerianthus lloydii, Owenia, Echinocyamus pusillus, Spiophanes wigleyi, Aonides paucibranchiata*;
- Cluster C – *Cerianthus lloydii, Owenia, Nematoda, Natatolana borealis, Spio symphyta*;
- Cluster D – *Nematoda, Owenia, Tanaissus Danica, Echinocyamus pusillus, Pisione remota*.

Correlations tests were carried out to assess whether the observed differences in community composition were a result of any relationships between the biological community and environmental parameters. Tests between the macrofaunal community and PSD showed that there was no significant correlation between the data sets, which was to be expected considering the lack of clear sediment gradient compositions across the survey area and the high heterogeneity throughout the sampling stations. Further tests were carried out between the macrofaunal dataset and separate subsets of hydrocarbon and metal concentrations which additionally showed no significant relationship between the macrofaunal community and the hydrocarbon concentrations (BSL, 2021b).

The differentiation between the different clusters was concluded as a result of variation in species composition. Cluster B showed the highest number of species and individuals however, this was not replicated for any of the richness of equitability biased diversity indices. Cluster D showed the widest range in numbers of individuals but the narrowest for numbers of species and Cluster C showed the lowest number of species and richness. The differences between the clusters were explored by assessing the average percentage contribution of major phyla and the total number of individuals and species within each. The results showed that all Clusters were dominated by Annelida, except Cluster C which was dominated by solitary epifauna. In terms of the contribution to numbers of species, the clusters showed fairly similar phyletic composition with all Clusters also dominated by Annelida, which accounted for the greatest proportion of the overall species richness (BSL, 2021b).

Comparisons with Other Regional Surveys

The macrofauna community recorded at Victory is broadly similar to that identified from previous surveys undertaken in the wider West of Shetland region.

The proposed Glenlivet Route 2 pipeline, which crosses through the main Victory area, was characterised by a moderately dense and diverse infaunal community. The survey corridor was dominated by the spionid polychaetes *Spiophanes wigelyi* and *Aonides paucibranchiata* (Fugro, 2011).

Previous surveys at the Edradour manifold found the infauna to be dominated by the oweniid polychaete *Galathowenia oculata*, together with the tube-dwelling anemone *Cerianthus lloydii* and the spionid polychaete *Aonides paucibranchiata*. Other dominant taxa included the polychaete *Chone collaris, Myriochele danielsseni, Spiophanes wigleyi, Prionospio steenstrupi, Owenia fusiformis, Glycera lapidum* and *Notomastus latericeus*. The anemone *Cerianthus lloydii*, was the only species present in all samples (100% frequency), although the polychaetes *Galathowenia oculata* and *Notomastus latericeus* were present in almost every sample (Total, 2017).

Along the Yell Sound pipeline route, the most abundant taxon overall was the glycerid polychaete worm *Glycera* sp. The second most abundant taxon was the pisionid polychaete worm *Pisione remota*, with the oweniid polychaete *Galathowenia fragilis* being the third most abundant taxon.

4.3.3 Fish and Shellfish

Distribution of Adult Populations

Fish are separated into pelagic species, which occur in shoals swimming in mid-levels of the water, typically making extensive seasonal movements or migrations between sea areas and demersal species, which live on or near the seabed.

Although the distribution of adult fish populations is highly fluid, analysis of recent fisheries landing and effort data suggests that adult populations of pelagic species such as mackerel (*Scomber scombrus*) and herring (*Clupea harengus*) make up a large proportion of catches in the vicinity of the Victory field (Marine Scotland, 2021b). Large numbers of mackerel are known to move northwards along the continental shelf edge towards the northern North Sea and Scottish Continental Shelf in the spring, having overwintered in the south west of the UK (DECC, 2016).

Additionally, demersal species such as saithe (*Pollachius virens*), European hake (*Merluccius merluccius*), monkfish (anglerfish; *Lophius piscatorius*), cod (*Gadus morhua*), ling (*Molva molva*) and haddock (*Melanogrammus aeglefinus*) are relatively abundant in this area (DECC, 2016; Marine Scotland, 2021b). In particular, monkfish or anglerfish (*Lophius* spp.) are one of the most commercially important species for the Scottish fishing fleet in the West of Shetland. Monkfish can be found on various seabed types, from shallow, inshore waters down to depths of up to 1,100 m, with high densities present along the shelf break (Fernandes, 2010). Anecdotal evidence from the Scottish Fishermen's Federation (SFF) regarding preferred trawling ground for vessels targeting monkfish indicates that this species prefers the more raised, firmer, sandy areas of the seabed on the West of Shetland continental shelf, similar to that found over the Victory area (SFF, 2013). Monkfish were also observed in the area during the environmental baseline survey (BSL, 2021b).

A number of shellfish species are also present in the waters of the West of Shetland. Crabs and lobsters are generally confined to inshore rocky areas whilst the commercially valuable crustacean *Nephrops norvegicus* (or langoustine) and scallops have a more offshore distribution. *Nephrops* are the most important shellfish species in the Scottish continental shelf and slope down to depths of 600 m (DECC, 2016). This species prefers fine sandy to muddy sediments; however, fisheries landings data suggests that shellfish are not particularly abundant in the area (Marine Scotland, 2021b).

Other fish species observed during the Victory environmental baseline survey include teleost fish Gobiidae, Pleuronectidae including *Limanda limanda* and Sebastes. Additionally, hermit crabs *Paguridae* were observed (BSL, 2021b).

Spawning and Nursery Grounds

The North-East Atlantic and North Sea is split into a statistical grids called ICES Rectangles in order to map statistical information about the area. UKCS Blocks 207/1, 206/4 and 206/5, in which the proposed Victory development is situated, are located within International Council for the Exploration of the Sea (ICES) Rectangles 50E7 and 50E8.

Species that may spawn within ICES Rectangles 50E7 and 50E8 include herring, haddock, lemon sole (*Microstomus kitt*) Norway pout (*Trisopterus esmarkii),* saithe, sandeels (*Ammodytes* spp.) and whiting (*Merlangius merlangus*). ICES Rectangles 50E7 and 50E8 also act as a nursery grounds for anglerfish, blue whiting (*Micromesistius poutassou*), cod, common skate (*Dipturus batis-complex*), European hake, haddock, herring, horse mackerel (*Trachurus trachurus*), lemon sole, ling, mackerel, Norway pout, saithe, sand eel, spotted ray (*Raja montagui*), spurdog (*Squalus acanthias*) and whiting (see Table 4.11 and Figure 4.16 and Figure 4.17 ; Coull *et al*., 1998; Ellis *et al*., 2012;).

A number of fish species, including Norway pout, have pelagic eggs and/or larvae (i.e. they release large numbers of eggs directly into the water column; DTI, 2001; Nash *et al.,* 2012; FishBase, 2021). The spawning grounds of these species can cover extensive areas, leaving them less vulnerable to disturbance from point sources (DECC, 2016). While other fish species, including sandeels, have a dependency on specific substrata for spawning, leaving them more vulnerable to disturbance from point sources. Sandeels are common in sandy areas across the Scottish Continental Shelf area (DECC, 2016) and represent a key food source for predatory fish and seabirds (DTI, 2003). Sandeel eggs are demersal and are laid in sticky clumps on clean, sandy sediments therefore hatching success and recruitment can be affected by activities that disturb seabed sediments. PSA of the Victory seabed sediment samples showed an overall sand dominance with minimal gravel and fines content, with 60% of stations classified as 'Slightly gravelly sand' and 30% of stations classified as 'Gravelly sand' (see Section 4.2.2). However, sandeels prefer slightly shallower water depths (20 - 100 m; Lancaster *et al.*, 2014) than those found across the Victory Field (133 to 304 m). Therefore while sandeels and sandeel spawning grounds may be present, the Victory field area is unlikely to offer prime habitat for this species.

Cod spawning habitats in the northwest North Sea have also been predicted by González-Irusta and Wright, 2016 using modelling. The preferred spawning substrate for cod was predicted as coarse sand compared with mud or sand, with high abundance of cod in the spawning stage located in the waters around the Shetland Islands. As noted above, PSA of the Victory seabed sediment samples showed an overall sand dominance with minimal gravel and fines content, therefore, the area may be favourable for cod spawning. However, the Victory development is located in waters with a minimum depth of 133 m and cod spawning has been shown to rapidly decline beyond 123 m, with mature cod moving to shallower banks to spawn (González-Irusta and Wright, 2016). Additionally, the model predicts that cod prefer spawning areas with temperatures around 5-7 °C, the average sea temperature within the Victory development area ranges from 8-10°C, therefore the area may not be ideal for cod spawning.

Herring spawning usually takes place in shallower waters at depths of between 15-40 m, where herring deposit their sticky eggs on coarse sand and gravel, although spawning may also take in the open sea, as long as waters are well-mixed, and temperature and salinity tolerance are wide (DECC, 2016). The Victory development is located in waters which are deeper (minimum depth 113 m) than the depths at which herring spawning usually takes place and seabed sediment samples from the Victory development have shown a minimum gravel content, therefore, the area may not be suitable for herring spawning.

Although many of the species that may utilise the waters surrounding the proposed Victory development area as spawning and / or nursery grounds are fairly widespread throughout the region, a number of these species are listed as PMFs in Scottish waters. These include the anglerfish (monkfish), blue whiting, cod, herring, horse mackerel, ling, mackerel, Norway pout, sandeels (*Ammodytes marinus* offshore), spurdog (also known as the spiny dogfish) and whiting (SNH, 2014; Tyler-Walters *et al.*, 2016). Sandeels (*A. marinus* offshore) are also listed as an MPA search feature in Scottish waters (Tyler-Walters *et al.*, 2012). Additionally, a number of species present within the vicinity of the Victory development are on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species. Common skate is listed as 'Critically Endangered' and globally, cod, horse mackerel, haddock are listed as 'Vulnerable' globally. All other species are listed as 'Least Concern' (IUCN, 2022). In UK waters there has been significant recent declines of sandeel, cod, haddock and whiting as a result of warming waters over the last 30 years (OPRED, 2022).

Table 4.11: Fish Spawning and Nursery Species within the Proposed Victory Development Area (ICES Rectangles 50E7 and 50E8) (Coull *et al.,* 1998; Ellis *et al.,* 2012)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Anglerfish (monkfish)[1]	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
Cod	N	N	N	N	N	N	N	N	N	N	N	N
Common skate	N	N	N	N	N	N	N	N	N	N	N	N
European hake	N	N	N	N	N	N	N	N	N	N	N	N
Haddock	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
Horse mackerel[2]	N	N	N	N	N	N	N	N	N	N	N	N
Lemon sole	N	N	N	N	N	N	N	N	N	N	N	N

Species	J	F	M	A	M	J	J	A	S	O	N	D
Ling	N	N	N	N	N	N	N	N	N	N	N	N
Mackerel	N	N	N	N	N	N	N	N	N	N	N	N
Norway pout	N	N	N	N	N	N	N	N	N	N	N	N
Saithe	N	N	N	N	N	N	N	N	N	N	N	N
Sandeel	N	N	N	N	N	N	N	N	N	N	N	N
Spotted ray	N	N	N	N	N	N	N	N	N	N	N	N
Spurdog[3]	N	N	N	N	N	N	N	N	N	N	N	N
Whiting	N	N	N	N	N	N	N	N	N	N	N	N
Key												
	Spawning		Peak Spawning		N	Nursery		N	High Intensity			

[1] Insufficient data available on spawning grounds

[2] Horse mackerel appear to be widespread and with no spatially discrete nursery grounds (*Ellis et al., 2012*).

[3] Viviparous species (gravid females can be found all year) (*Ellis et al., 2012*)

In addition to the mapping of spawning and nursery grounds of key commercial fish species, more recent spatial modelling of the probability of the occurrence of aggregations of 0 group fish species (i.e. fish in the first year of their life) and / or larval stages has been undertaken. This has provisionally identified the spatial distribution of sensitive life stages of commercial fish species (in line with mapping from Coull *et al.,* 1998 and Ellis *et al*., 2012) that could be affected by offshore oil and gas operations (Aires *et al*., 2014). 0 group fish are considered to be most sensitive to physical damage from oil and gas operations (particularly through seismic surveying and piling). In general, the juvenile stages of many commercial fish species remain within coastal areas for a year or two before moving offshore (DTI, 2003), therefore juveniles are less likely to utilise the offshore waters of the proposed Victory development area as a significant habitat.

Based on spatial modelling of 0 group fish, the proposed Victory development area is not considered to be of high importance to juvenile fish species in their first year of development (Figure 4.18 and Figure 4.19). Of the species mapped, there is a low probability of 0 group aggregations of whiting, sprat, sole, plaice (*Pleuronectes platessa*), mackerel, horse mackerel, herring and cod and moderate probability of Norway pout, hake, haddock, blue whiting, anglerfish in the vicinity of the proposed Victory development (Aires *et al.,* 2014). It is important to note however that the specific locations of these sites of fish sensitivity are dynamic and may shrink or expand or move over time as maps are updated (Aires *et al*., 2014).

Figure 4.16: Fish Spawning and Nursery Areas across the Proposed Victory Development Area

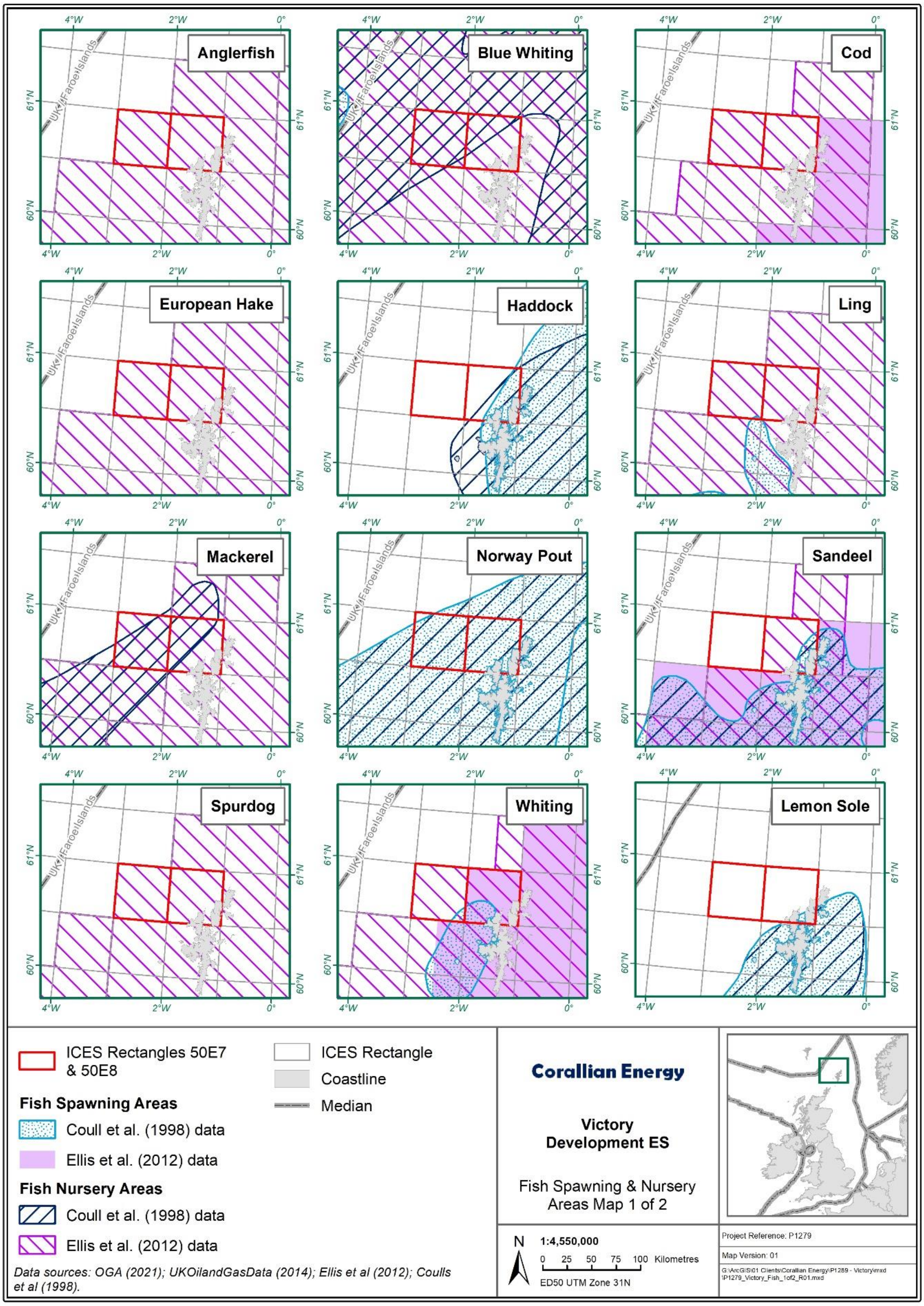


Figure 4.17: Fish Spawning and Nursery Areas across the Proposed Victory Development Area

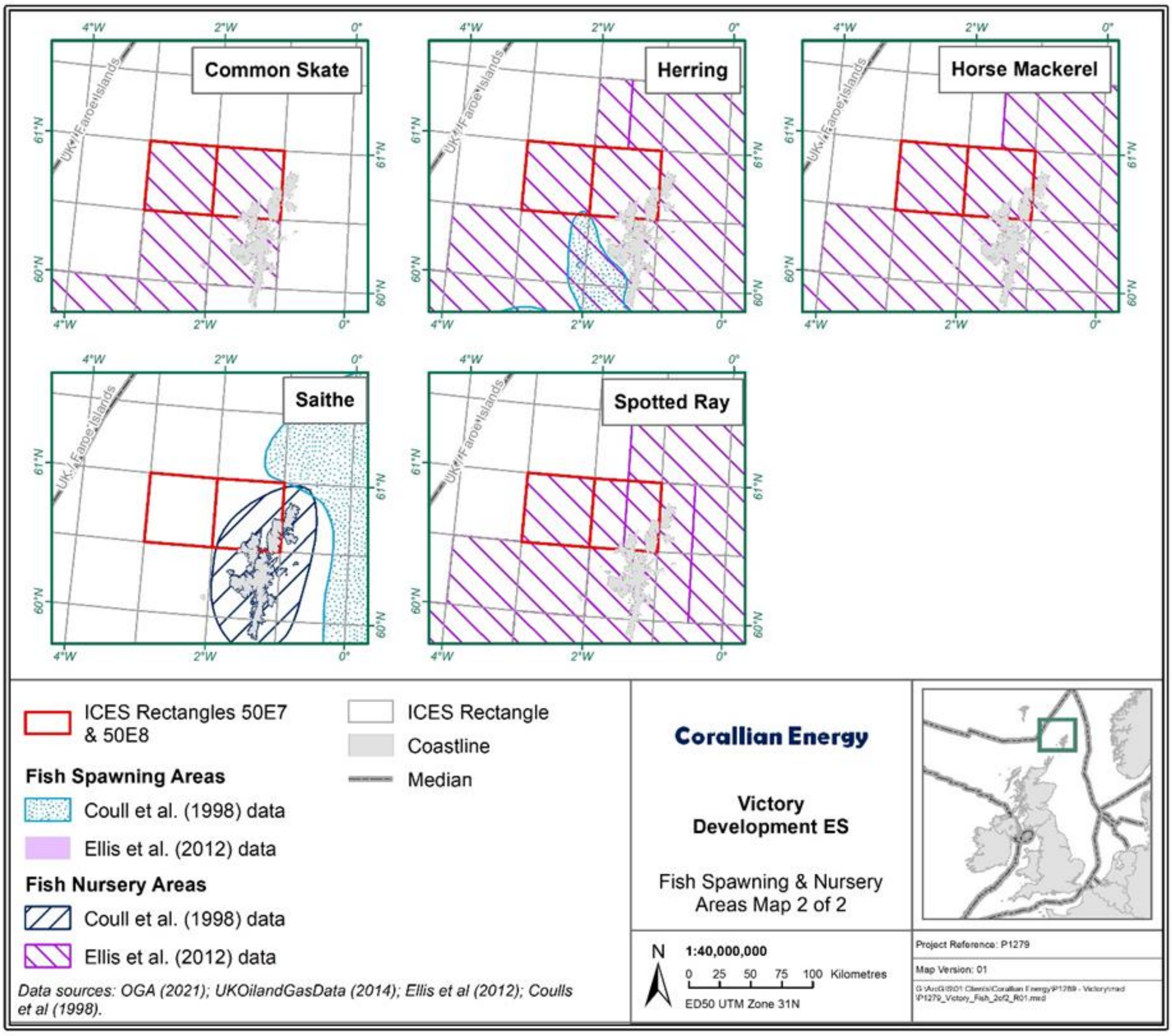


Figure 4.18: Probability of 0 Group Fish Aggregations in the Vicinity of the Victory Development Area

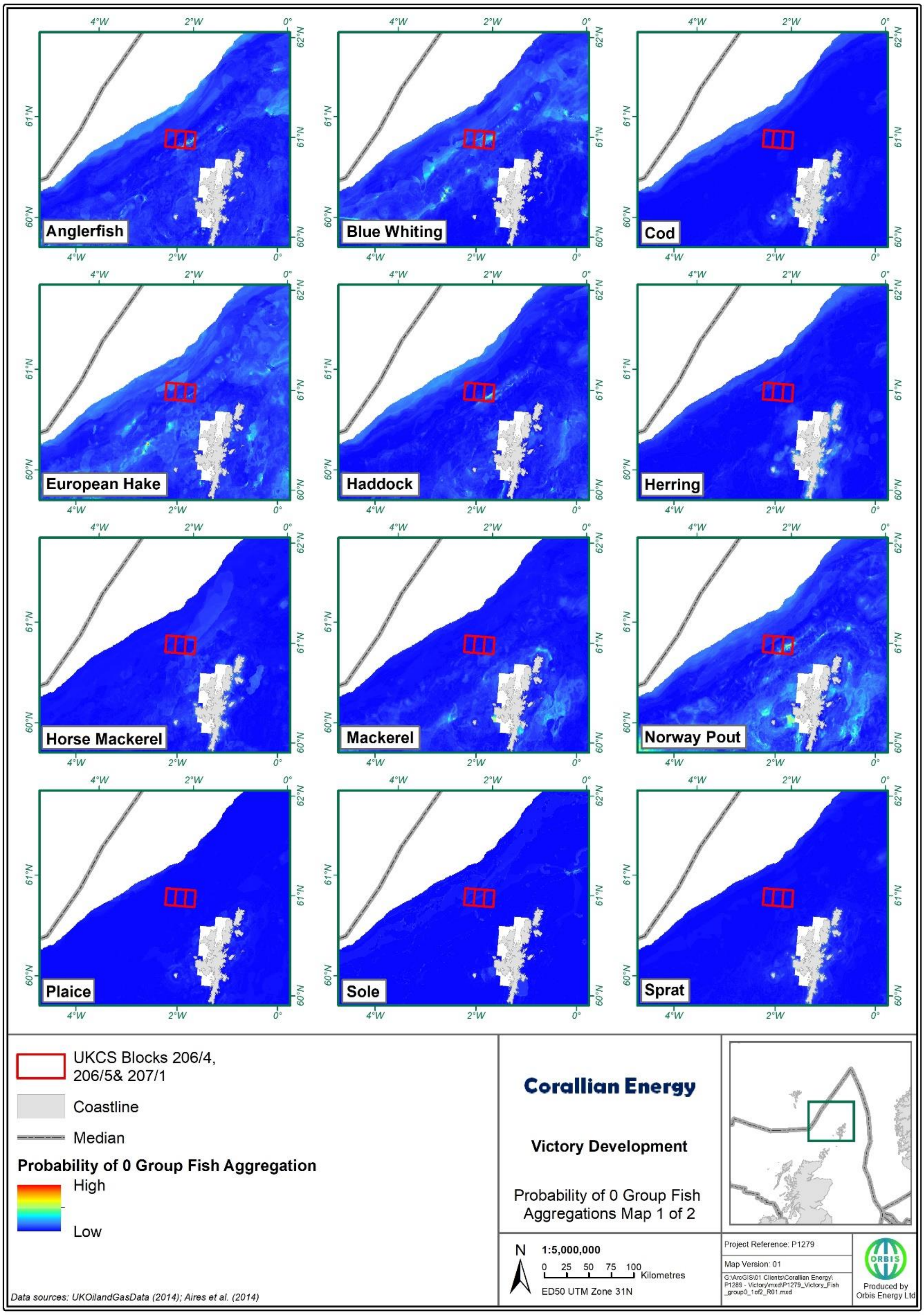
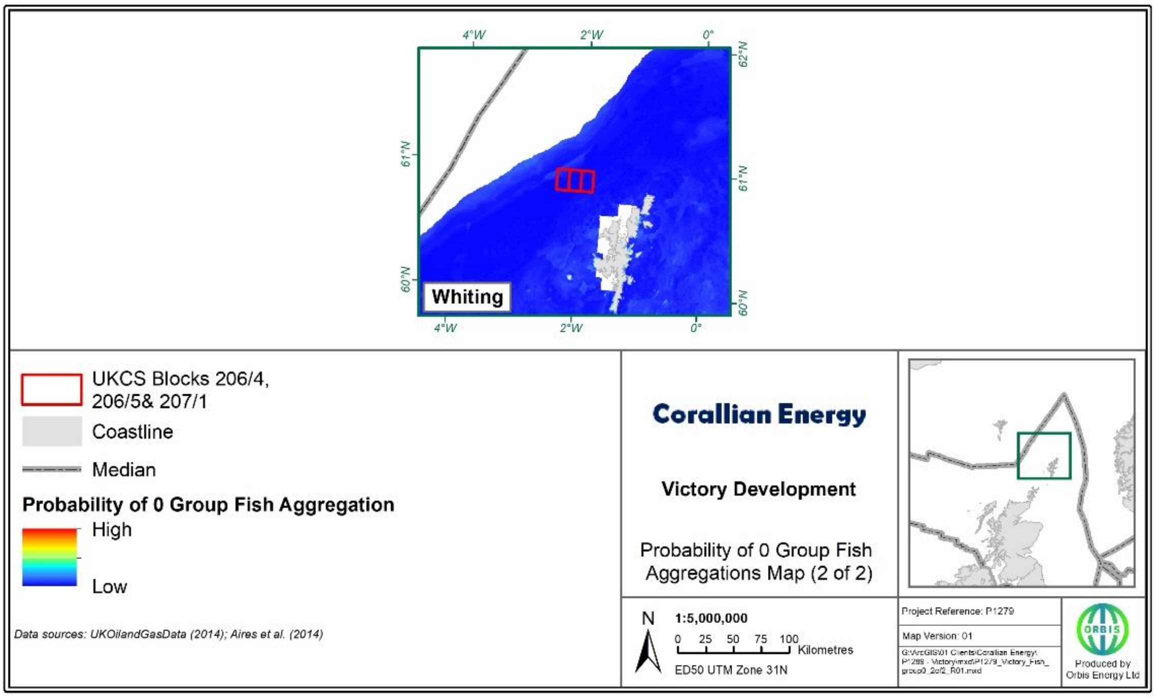


Figure 4.19: Probability of 0 Group Fish Aggregations in the Vicinity of the Victory Development Area



Elasmobranchs

Elasmobranchs encompasses species of sharks, skates and rays. These species differ from other fish by having a skeletal structure made out of cartilage as opposed to bone. They typically have a slow growth rate and low fecundity, leaving their populations vulnerable to over-fishing, habitat degradation and pollution events however, their distribution is wide throughout the world's oceans (Baxter *et al.,* 2011).

Surveys of the distribution of elasmobranchs in UK waters were undertaken by Ellis *et al.* in 2004 and have also been reviewed by Baxter *et al.* (2011). Species that have been recorded in the West of Shetland at various times throughout the year, and therefore may be present in the vicinity of the proposed Victory development area, are listed in Table 4.12 (Ellis *et al.,* 2004; Baxter *et al.,* 2011).

Table 4.12: List of Elasmobranch Species Likely to be found in the Victory Development Area

Common Name	Scientific Name	Depth Range (metres)	Global IUCN Status [1]	European IUCN Status[1]
Basking shark	*Cetorhinus maximus*	0 - 910	Endangered	Endangered
Blue shark	*Prionace glauca*	0 - 600	Near Threatened	Near Threatened
Common skate	*Dipturus batis*	84 - 271	Critically Endangered	Critically Endangered
Cuckoo ray	*Leucoraja naevus*	12 - 290	Least Concern	Least Concern
Lesser-spotted dogfish	*Scyliorhinus canicula*	6 - 308	Least Concern	Least Concern
Porbeagle shark	*Lamna nasus*	200 - 700 [2]	Vulnerable	Critically Endangered
Portuguese dogfish	*Centroscymnus coelolepis*	270 - 3,700 [3]	Near Threatened	Endangered

Common Name	Scientific Name	Depth Range (metres)	Global IUCN Status [1]	European IUCN Status[1]
Sandy ray	*Leucoraja circularis*	108 - 432	Endangered	Endangered
Spurdog (spiny dogfish)	*Squalus acanthias*	15 - 528	Vulnerable	Endangered
Starry ray	*Amblyraja radiata*	32 - 209	Vulnerable	Least Concern

[1] Status as of September 2021
[2] Sometimes found in shallower water close inshore (Baxter *et al*., 2011)
[3] Recorded in commercial fisheries catches in the vicinity of the proposed development (Baxter *et al.,* 2011)

A number of the species listed in Table 4.12 are also PMFs including; the basking shark, common skate, porbeagle shark, Portuguese dogfish, sandy ray and spurdog (spiny dogfish) (SNH, 2014; Tyler-Walters *et al.,* 2016). In addition, the basking shark and common skate are also listed as NC MPA search features whereby MPA designation should seek to protect these features (Tyler-Walters *et al*., 2012).

Information relating to the distribution of basking sharks on the Scottish continental shelf is limited (DTI, 2003). Basking sharks appear to be most regularly recorded in coastal areas of the UK with seasonally persistent tidal fronts (including western Scotland). They are mainly recorded in surface waters from April to September, when mostly immature females are seen. In late summer, basking sharks are thought to disperse offshore but their winter distribution remains unknown, but is thought to be in deep water (DTI, 2003). Research (Sims *et al*., 2003) suggests that they make extensive migrations both vertically and horizontally to locate high concentrations of plankton that will often be associated with fronts, and that they principally migrate north to south during the winter months along the continental shelf of Europe (Sims *et al*., 2003; 2005).

4.3.4 Seabirds

Offshore Distribution and Abundance

Seabird presence and abundance is often used as an indicator for assessing the state of the marine environment as their populations and distribution varies with changes in prey abundance, weather, predation and pollution (Baxter *et al.,* 2011). Scotland holds internationally important numbers of 24 species of breeding seabirds (Baxter *et al*., 2011), as well as providing habitat for a number of overwintering or passage seabird species, and the coastal waters around the Shetland Islands hold vulnerable concentrations of seabirds all year round.

The proposed Victory drilling and subsea installation activities are scheduled to take place between the months of May to October. The work will therefore coincide with the breeding bird season when seabirds from nearby coastal SPAs are likely to be foraging within the vicinity of Victory.

The European Seabirds at Sea (ESAS) database is the most complete and longstanding dataset detailing the distribution of seabirds at sea, compiling a range of boat and transect data over a period of 29 years. During the breeding season (March - September) the database predicts that at-sea seabird densities in the proposed Victory development area are relatively high at less than 490 seabirds per km^2, with the area considered to be important for great skua (*Stercorarius skua*) and northern fulmar (*Fulmarus glacialis*) (JNCC, 2019; Kober *et al*., 2010).

Of note is that the Seas off Foula Special Protection Area (SPA) is located approximately 57 km to the south east of the proposed Victory development area (refer to Section 4.3.6). This site protects important feeding grounds for seabirds breeding on Foula and beyond, including the largest marine aggregation of great skuas in the UK. Great skua have a maximum foraging range of 1,003 km, they are aggressive hunters and scavengers who plunge dive to catch their prey which includes fish, carrion and other birds such as puffins (Woodward *et al.,* 2019; RSPB, 2021). Similarly, fulmar also have a large foraging range of 2,736 km, they have a broad prey spectrum from zooplankton to large fish and have been found to feed on fish waste, crustaceans and sandeels. Fulmar surface feed, surface dive and plunge dive to catch their prey and can dive several metres under the water (Garthe & Furness, 2001; Woodward *et al.,* 2019, RSPB, 2021).

Several other SPAs are located along the coastline of the Shetland Islands, the closest of which are the Ramna Stacks and Gruney SPA and the Ronas Hill -North Roe and Tingon SPA located 33 km and 34 km south east of Victory respectively (see Section 4.3.6). Seabird species originating from these SPAs may therefore also forage within the offshore waters of the proposed Victory development area during the breeding bird season. Based on the mean maximum foraging ranges taken from Woodward *et al.,* 2019, species which are likely to be present in the Victory area whilst the proposed drilling and subsea installation activities are ongoing, in addition to great skua and northern fulmar as noted above, include kittiwake (*Rissa tridactyla*) (156.1±144.5 km), great black-backed gull (*Larus marinus*) (73 km), herring gull (*Larus argentatus*) (58.8±26.8 km), Atlantic puffin (137.1±128.3 km), gannet (*Morus bassanus*) (315.2±194.2 km), razor bill (*Alca torda*) (88.7±75.9 km), common guillemot (*Uria aalge*) (73.2±80.5 km), European storm petrel (*Hydrobates pelagicus*) (336 km) and Arctic tern (*Sterna paradisaea*) (25.7±14.8 km) (see Table 4.13 for further details). Arctic skua (*Stercorarius parasiticus*), Leach's storm petrel (*Oceanodroma leucorhoa*) and shag (*Phalacrocorax aristotelis*) may also be present.

Of these species, kittiwake, European storm petrel and Leach's storm petrel surface feed and shallow dive for fish and shrimp, herring gulls are omnivious and feed on a range of items such as carrion, young birds, fish, and small mammals, similarly great black-backed gulls are opportunistic feeders and will feed on shellfish, other seabirds and carrion (RSPB, 2021). Puffins and razor bill surface dive to catch their prey feeding on fish including sandeels, gannets plunge dive into the sea for fish and Arctic skua feed mainly by kleptoparasitism, taking food from other seabirds (Tasker, 1985; YPTE, 2021; Wildlife Trusts, 2021). Guillemots are excellent diving seabirds, they can dive to depth of a few hundred metres and feed on fish and crustaceans (RSPB, 2021). Arctic tern are surface feeders which feed mainly on sandeels, crustaceans, molluscs and insects (RSBP, 2021). Shags are diving seabirds which forage in deeper water for fish and occasionally crustacean and molluscs (RSPB, 2021).

Table 4.13: Seabirds Potentially Foraging in the Proposed Victory Field Development Area during the Breeding Bird Season (JNCC, 2021c; Woodward *et al.,* 2019)

Species	Mean Maximum +1SD Foraging Range (km)	Originating SPA / Ramsar	Type of Feeder
Leach's storm petrel (*Oceanodroma leucorhoa*)	-	Ramna Stacks and Gruney, Foula, Mousa	Surface
Great skua (*Catharacta skua*)	443.3 ± 487.9	Ronas Hill - North Roe and Tingon, Hermaness, Saxa Vord and Valla Field, Fetlar, Seas off Foula, Foula, Noss	Diver
Gannet (*Morus bassanus*)	315.2 ± 194.2	Hermaness, Saxa Vord and Valla Field, Noss	Diver
Puffin (*Fratercula arctica*)	137.1 ± 128	Hermaness, Saxa Vord and Valla Field, Seas off Foula, Foula	Surface / Diver
Fulmar (*Fulmarus glacialis*)	542.3 ± 657.9	Hermaness, Saxa Vord and Valla Field, Seas off Foula	Diver / Surface
Guillemot (*Uria aalge*)	73.2 ± 80.5	Hermaness, Saxa Vord and Valla Field, Seas off Foula, Foula, Noss	Diver
Kittiwake (*Rissa tridactyla*)	156.1 ± 144.5	Hermaness, Saxa Vord and Valla Field	Surface
Arctic tern (*Sterna paradisaea*)	25.7 ± 14.8	Fetlar, Papa Stour, Foula, Mousa	Surface

Species	Mean Maximum +1SD Foraging Range (km)	Originating SPA / Ramsar	Type of Feeder
Arctic skua (*Stercorarius parasiticus*)	-	Fetlar	Diver
Shag (*Phalacrocorax aristotelis*)	-	Foula	Diver
Razorbill (*Alca torda*)	88.7±75.9	Foula	Diver

The Joint Nature Conservation Committee (JNCC) prepares the latest analysed trends in abundance, productivity, demographic parameters and diet of breeding seabirds, from the Seabird Monitoring Programme (JNCC, 2021b). This data provides at-a-glance UK population trends as a percentage of change in breeding numbers from complete censuses. From 2000 to 2019, the following population trends for species known to use offshore waters of the proposed Victory development area have been recorded: northern fulmar (-33%), northern gannet (+34%), Arctic skua (-70%), kittiwake (-29%), great black-backed gull (-23%) and guillemot (+60%).

Climate change is considered to be one of the primary causes of the decline in seabird populations in the UK; climate change affecting populations either directly e.g. mortality from extreme weather or indirectly via changes in in food supply. Lack of food availability is a possible cause of poor breeding success in Arctic skua; this species steals prey (e.g. sandeels) from other seabird species, and reduced sandeel numbers around Shetland, thought to be as result of hydro-climatic, sea temperature and oceanographic changes, has reduced prey abundance and availability for these host species, and thus reduced feeding opportunities for Artic skuas (OPRED, 2022)

Once breeding is complete seabirds disperse into areas further offshore, although the extent to which they disperse varies between species. During the winter months (November – March) the at-sea seabird density in the proposed Victory development is predicted to be lower compared to seabird density in the breeding season, at less than 99 seabirds per km^2. The most abundant species found in the area at this time include kittiwake and fulmar, with guillemot also present during the post breeding dispersal period (JNCC, 2019; Kober *et al.*, 2010). Puffin distribution becomes scattered, with birds from Shetland and Orkney colonies moving south and wintering in the North Sea, although some birds move north west of Shetland to beyond the shelf break and over deeper waters of the Faroe Bank, the Faroe-Shetland Channel and the Wyville-Thomson Ridge. Wintering populations of little auk (*Alle alle*) can also be found along the north coast of the Shetland Islands, where they feed on plankton and small marine creatures (DECC, 2016).

Waggitt *et al.* 2019 analysed seabird survey data in the North-East Atlantic between 1980 and 2018 using Species Distribution Models (SDM) to produce seabird distribution maps. Prediction distributions for January and July were produced to show variation between the coolest and warmest months. In the vicinity of the proposed Victory development area, in January, species which had a higher density of individuals per km^2 included black-legged kittiwake, herring gull, common guillemot, Northern fulmar and Northern gannet and razorbill. Additionally, species which had a higher density of individuals per km^2 in July included, black-legged kittiwake, common guillemot, Northern fulmar, Atlantic puffin, manx shearwater, European storm petrel, great skua, Northern Gannet and razorbill (Waggitt *et al*., 2019).

Note that there are no bird species identified as PMFs in Scottish waters as they are protected under the EU Birds Directive (SNH, 2014; Tyler-Waters *et al*., 2016). However, the black guillemot is listed as a NC MPA search feature in Scottish waters thereby encouraging the designation of MPAs to protect this species (Tyler-Walters *et al*., 2012). Unlike other auk species, the black guillemot is typically found feeding in inshore waters and rarely disperses from its breeding areas, even in winter (DECC, 2016). The species has a short mean maximum foraging range of 4.8±4.3 km (Woodward *et al.,* 2019) and, as such, it is unlikely to be found in the vicinity of the proposed Victory development area.

Seabird Sensitivity to Oiling

Seabird sensitivity to oiling varies considerably throughout the year and is dependent on a variety of factors, including time spent on the water, total biogeographical population, reliance on the marine environment and potential rate of population recovery (DECC, 2016). The Seabird Oil Sensitivity Index (SOSI) (Webb *et al*., 2016) combines seabird data collected between 1995 and 2015 and individual seabird species index values to create a single measure of seabird sensitivity to oil pollution. The SOSI score for each UKCS Block is ranked into sensitivity categories, from 1 (extremely high sensitivity) to 5 (low sensitivity). An assessment of the median SOSI scores for Blocks 207/1, 206/4 and 206/5, within which the proposed Victory development area is located, indicate that sensitivity is generally low between May and September, low to medium between November and February, high to very high in October and low to high in March (Table 4.14; Webb *et al*., 2016).

Table 4.14. Seabird Sensitivity to Oiling within the Proposed Victory Area

UKCS Block	J	F	M	A	M	J	J	A	S	O	N	D
206/10	4	5	5	*5*	5	4	5	5	*3*	3	*3*	*4*
206/4	**4**	**5**	**3**	**4**	**5**	**5**	**5**	**5**	**5**	**2**	**5**	**5**
206/5	**5**	**5**	**5**	***5***	**5**	**5**	**5**	**5**	**5**	**3**	**5**	**5**
206/8	3	5	5	3	5	5	5	5	5	3	*3*	*3*
206/9	3	5	*5*	*5*	5	5	5	5	5	2	*2*	*3*
207/1	**5**	**5**	**4**	***4***	**5**	**5**	**5**	**5**	**5**	**3**	**5**	**4**
207/2	4	5	4	*4*	5	3	5	5	5	3	5	5
207/6	5	5	5	*5*	5	2	5	5	5	3	2	*2*
207/7	4	5	3	*3*	5	2	4	5	5	3	5	*4*
208/26	5	5	4	*4*	5	5	5	5	5	3	5	5
208/27	4	5	4	5	5	5	5	5	5	3	5	5
21/30	5	5	5	*5*	*5*	5	5	5	5	*5*	*0*	*5*
214/28	4	*3*	3	4	5	5	5	5	5	2	5	*4*
214/29	5	5	4	4	5	5	5	5	5	2	5	5

Key: 1 = Extremely High; 2 = Very High; 3 = High; 4 = Medium; 5 = Low; 'N' = No Data.
SOSI sensitivity category in red and underlined indicates an indirect assessment of SOSI scores, in light of coverage gaps.
Rows in bold indicate the UKCS blocks within which the proposed Victory development area is located.

Wildfowl and Waders

The Shetland Islands coastline is of particular importance during the spring and autumn for migratory waterfowl. The variety of habitats within the coastal areas adjacent to the proposed Victory development area, means that species assemblages vary significantly with exposure to the coastline and the substratum type. Smaller waders such as the dunlin, are generally confined to sheltered muddy shores around estuaries, whilst sandy, more exposed shorelines support species such as knot (*Calidris canutus*) and oystercatcher (*Haematopus longirostris*) (DTI, 2005).

Whilst relatively less important for migratory waders and wildfowl than other key areas of Scotland, the Shetland Islands also supports internationally important populations of eider (*Somateria spectabilis*) which moult on Shetland between August and September and overwinter from November to March (SOTEAG, 2015). Other important species include the great northern diver (*Gavia immer*), the largest population of Slavonian grebe (*Podiceps auritus*) in Great Britain (SOTEAG, 2015), pink-footed goose (*Anser brachyrhynchus*) and mute swan (*Cygnus olor*) which overwinter or migrate to these areas (DTI, 2005; SSMEI, 2010). In addition, the Shetland Islands are a major habitat for the whimbrel (*Numenius phaeopus*) and support up to 95% of Britain's breeding population (Massey, 2016).

4.3.5 Marine Mammals

The waters between the Faroe Islands and Shetland support a rich and diverse population of cetaceans (whales, dolphins and porpoise) and pinnipeds (seals), particularly in comparison to the North Sea region where a low diversity and abundance of species is found. In addition, the coast and islands of western Scotland are particularly important for otters (NatureScot, 2021).

Cetaceans

The proposed Victory development area is situated on the continental shelf in the West of Shetland region, approximately 100 km south of the Faroe-Shetland Channel. The waters of the channel support important and diverse populations of cetaceans. The confluence of ocean currents results in strong upwelling of deeper waters rich in nutrients, in turn attracting higher trophic levels including zooplankton and fish, enabling several species to live in the area throughout the year. Certain species are resident in the shallower waters of the shelf where they feed all year round such as the minke whale (*Balaenoptera acutorostrata*) the smallest of the larger filter feeding whales, white-beaked dolphins (*Lagenorhynchus albirostris*) and harbour porpoises (*Phocoena phocoena*) (Reid *et al.,* 2003). White-sided dolphins (*Lagenorhynchus acutus*) and larger species such as killer whales (*Orcinus orca*) and long-finned pilot whales (*Globicephala melas*) preferentially inhabit the deeper waters beyond the continental shelf and are rarer in the shallow waters around the proposed development area (Reid *et al.,* 2003).

Other cetaceans, including blue (*Balaenoptera musculus*), fin (*Balaenoptera physalus*), sei (*Balaenoptera physalus*), humpback (*Megaptera novaeangliae*), sperm (Physeter macrocephalus), right (*Eubalaena* spp.) and northern bottlenose whales (*Hyperoodon ampullatus*), are thought to use the Faroe-Shetland Channel as a migratory pathway, moving through the area to summer feeding grounds in the north, before returning to more southern overwintering and breeding grounds (JNCC, 2014a).

<u>Resident Species</u>

Several species of cetacean are resident (may be present throughout the year) within the West of Shetland area, where their distribution is governed primarily by water depth and availability of food resources. The proposed Victory development area is located in the relatively shallow waters of the continental shelf, where minke whales, white-beaked dolphins, and harbour porpoises feed year round (Reid *et al.,* 2003). These species all feed on a variety of fish species, particularly gadoids, herring and sandeels (Reid *et al.,* 2003; SNH, 2009). The Risso's dolphin has also been recorded in these shelf waters, although in fewer numbers, feeding on mainly octopus with some cuttlefish and squid (Reid *et al*., 2003). The distribution and abundance of these year round inhabitants of the continental shelf waters, and their movements in the vicinity of the proposed development, is summarised in Table 4.15.

The distribution of resident cetaceans, which favour the deep water of the Faroe-Shetland Channel, is also summarised in Table 4.15. Both long-finned pilot whales and Atlantic white-sided dolphins feed on a variety of squid and fish species. They tend to occur in deep water areas beyond the shelf edge, where their prey is more abundant. Killer whales have a very varied diet, feeding on fish, squid, seals, birds and other cetaceans, and have been observed in a range of water depths as a result. However, in the West of Shetland area, sightings suggest that they are primarily concentrated in the deep slope waters to the north. While favouring deeper waters, both white-sided dolphins and killer whales have been observed over shelf waters, and in the vicinity of the proposed development (Reid *et al*., 2003).

Table 4.15: Distribution of Whales, Dolphins and Porpoises in the Waters West of Shetland

Species	Abundance and Distribution
Year-Round Inhabitants of the Shelf Waters	
Harbour porpoise	Sightings of harbour porpoises are generally confined to shallow shelf waters, although individuals have occasionally been recorded in the deep water between Shetland and

Species	Abundance and Distribution
	the Faroe Islands. These small cetacean species typically occur in very small groups of up to only three individuals. On the continental shelf to the West of Shetland, harbour porpoises appear to be most abundant in the shallower waters to the south of the proposed Victory development area (SCANS-II, 2008).
White-beaked dolphin	This species is abundant and widely distributed on the continental shelf to the West of Shetland and Orkney. Although present year-round, most observations are between June and October (Reid *et al*., 2003). While they have been observed in the proposed Victory development area, sightings are more numerous off the north and west coasts of mainland Scotland.
Risso's dolphin	Although this species is often regarded preferring deeper offshore waters, most sightings around Scotland and the northern Scottish Isles have occurred over the continental shelf, in water depths of less than 200 m (Pollock *et al.,* 2000). The majority of sightings have been recorded around the Outer Hebrides, although small numbers have also been seen off Orkney and Shetland. Sightings around the proposed Victory development area are considered to be its most northerly limit.
Minke whale	This species is widely distributed throughout UK waters. Most sightings occur within the 200 m depth contour, indicating the inshore nature of this species. Sightings are most frequent around the Western Isles, with few records in the proposed Victory development area. Although this species occurs year round, most sightings are between June and August. While usually seen individually or in pairs, they may aggregate into groups of 10 to 15 individuals (Reid *et al*., 2003).
Year-Round Inhabitants of the Deeper Waters	
Atlantic white-sided dolphin	This species is frequently observed in groups numbering in the tens to hundreds and is one of the most abundant species found in the West of Shetland area. This species has an offshore distribution, and is observed along the shelf edge and into waters deeper than 1,000 metres. While they are found in these deep water areas year round, groups are frequently recorded in continental shelf waters during the summer months (Pollock *et al*., 2000).
Killer whale	Killer whales are distributed over both the continental shelf and in the deep offshore waters, with the main concentration of sightings occurring over the slope north and north west of Shetland (Stone, 1998; Pollock *et al.,* 2000). They have however, been recorded in the vicinity of the blocks of interest in low numbers. Although killer whales occur year round, sightings increase during the early summer months. The majority of sightings in the UK have been of individuals or groups of less than eight animals.
Long-finned pilot whale	Most pilot whale sightings occur along shelf slope north of Scotland, with the highest abundance in the deeper waters of the Faroe-Shetland Channel (Pollock *et al.,* 2000). These whales only occasionally venture into continental shelf waters, with very few sightings on the shelf in the West of Shetland area. Their diet of deep water squid influences this distribution. Pilot whales often occur in large pods, although surveys to the north and west of Scotland recorded an average group size of just over ten (Reid *et al*., 2003).

Migratory Species

With the exception of the smaller minke whale, the large baleen whales are not thought to be year-round residents of the Faroe-Shetland Channel, but instead use it as a migratory pathway. These whales move into these colder temperate waters to feed in summer. While some remain within the channel over summer, others travel onto polar areas further north, before returning to lower latitude overwintering and breeding grounds in autumn (DECC, 2016). Baleen whales differ from toothed whales (odontocetes) as they have baleen plates through which they filter feed zooplankton, particularly krill and other small pelagic prey, and their distribution is often related to oceanographic features such as fronts, upwellings, and associated areas in which prey availability is high.

Visual surveys have confirmed the presence of large baleen whales, at least in small numbers, during the summer months (Pollock *et al*., 2000). This seasonal occurrence may however, be misrepresented by the uneven distribution of survey effort across the year. Limited passive acoustic monitoring of cetacean vocalisations has suggested that blue, fin and humpback whales also occur in spring and autumn, with at least some individuals remaining throughout the year (Charif and Clark, 2000). However, there is currently insufficient data to give a reliable indication of the abundance or seasonal distribution of these whales within the Faroe-Shetland Channel.

On the basis of survey sightings and acoustic detections, Table 4.16 attempts to summarise the occurrence of large baleen whales within the Faroe-Shetland Channel. Blue, fin, humpback and sei whales are all considered to be open water species, favouring deep water areas. Almost all sightings of these whales have been recorded either over or beyond the shelf break (Pollock *et al*., 2000), concentrated along the 1,000 m depth contour. It is, therefore, unlikely that any of these whales would occur in the area of the proposed Victory development area.

Although sperm whales are a toothed whale species, they also use the Faroe-Shetland Channel as a migratory pathway. It is believed that only males migrate into these colder temperate waters to feed, before returning to warmer areas to breed. As a result, sightings increase between July and December, although evidence suggests that some individuals may remain year-round.

Table 4.16: Distribution of Large Migratory Baleen Whales within the Deepwater of the Faroe-Shetland Channel

Species	Abundance and Distribution
Blue whale	Blue whales are thought to breed in tropical waters during the winter months and then migrate to colder temperate and polar waters to feed in summer. Whaling records indicate that small numbers of blue whales regularly pass to west of the UK and Ireland in the deep waters off the continental shelf. Although there have been no recorded sightings of the blue whale to the West of Shetland (Reid *et al.,* 2003), acoustic monitoring has shown individuals to occur in the deep water of the channel during autumn and spring (Charif and Clark, 2000).
Fin whale	Fin whales use the Faroese shelf edge as a migratory channel, spending the summer months at high latitudes before returning to overwintering grounds. Fin whales are generally observed in deep water areas and are not expected in the vicinity of the proposed development (Swift *et al*., 2002). West of Shetland, peak numbers have been observed in July and August (Reid *et al*., 2003). However, acoustic monitoring has suggested that at least some individuals may be resident year-round (Charif and Clark, 2000).
Humpback whale	The humpback whale occurs globally, favouring waters over and along the edges of continental shelves. In winter they breed in tropical waters, while spending summer in temperate and polar waters. These whales have been sighted in the deep water in the West of Shetland area, although infrequently and in very small numbers (Pollock *et al.,* 2000). Although acoustic surveys have detected humpbacks over winter and in early spring (Charif and Clark, 2000), visual observations during seismic surveys have occurred during the summer months (PFML, 2016).
Sei whale	Sei whales migrate between summer feeding grounds off the Faroe Islands, Shetland and Norway, and lower latitude overwintering grounds. They are thought to reach Scottish waters between April and July, leaving during late August and September. They are considered to be pelagic deep water species, with most observations concentrated in the deep water to the southeast of the Faroe Islands (Pollock *et al.,* 2000). However, occasional sightings do occur in shallow waters off Shetland (Reid *et al*., 2003).

Beaked whales are a group of toothed whales which favour deep, oceanic waters, often far from shore. As such their ecology and distribution is not fully understood. It is known that they tend to occupy waters of intermediate depth, over sloping seabeds, and have often been reported to prefer areas of complex seabed topography, such as submarine canyons, shelf-edges and escarpments (MacLeod, 2005). Each species, however, may occupy its own niche within this generalised beaked whale habitat, based upon its own habitat preferences, including water depths, water temperatures and prey types. Sightings and strandings data have shown these whales occur within the Faroe-Shetland Channel, with almost all sightings records beyond the 1,000 m depth contour; however, rare observations have also been recorded from coastal waters of the Hebrides, Orkney, Shetland and the northern North Sea (Aguilar de Soto *et al.,* 2016 cited in DECC, 2016). Therefore, beaked whales may be present in the vicinity of the proposed Victory development area, but are unlikely to be present in significant numbers.

Recorded Sightings

The relative abundance of the most common species of cetaceans in this area of the North Sea can be derived from data obtained during the Small Cetacean Abundance of the North Sea (SCANS-III) aerial and ship-based surveys. This project identified the abundance of cetacean species within predefined sectors of the North Sea and North-East Atlantic. The proposed Victory development is located within SCANS-III Blocks S and T (see Figure 4.20). Harbour porpoise, minke whale and white-beaked dolphin have been recorded within these blocks (see Table 4.17; Hammond *et al*., 2017). It should be noted that although density estimates are shown in Table 4.17, they are only an example of what densities could be encountered in the area due to the wide-scale nature of the SCANS-III survey and the fact the data was only collected in July 2016.

Table 4.17: Cetacean Abundance and Density Recorded in SCANS-III Aerial Survey Blocks S and T (Hammond *et al.*, 2017)

Species	SCANS-III Block 'S'		SCANS-III Block 'T'		Total (Aerial Survey Blocks)	
	Abundance	Density [1]	Abundance	Density [1]	Abundance	Density [1]
Harbour porpoise	6,147	0.152	26,309	0.402	424,245	0.351
White-beaked dolphin	868	0.021	2,417	0.037	36,287	0.030
Minke whale	383	0.010	2,068	0.032	13,101	0.011

[1] Density is the number of individuals per km^2.

Data from the Cetaceans Atlas (Reid *et al.,* 2003) also records sightings of harbour porpoise, minke whale, white-beaked dolphin, as well as killer whale, pilot whale and the white-sided dolphin in the vicinity of the proposed Victory development area during various times of the year (see Table 4.18), although their overall presence is considered to be very low to low. However it should be noted that cetaceans move considerable distances and therefore there are many difficulties with accurately recording their abundance and distribution.

Table 4.18: Cetacean Sightings in the Vicinity of the Proposed Victory Development Area (Reid *et al.,* 2003)

Species	J	F	M	A	M	J	J	A	S	O	N	D
Harbour porpoise												
Killer whale												
Minke whale												

Species	J	F	M	A	M	J	J	A	S	O	N	D
Pilot whale	Low											
White-beaked dolphin							Low	Low				
White-sided dolphin							Very Low	Low				

Key (Numbers of individuals per hour of sightings effort)

High	(>100)
Medium	(10 – 100)
Low	(1 – 10)
Very Low	(0.01 – 1)
No sightings	

Management Units for Cetaceans

The UK Statutory Nature Conservation Bodies (SNCBs) have published Management Units (MUs) for the seven most common cetacean species in UK waters (bottlenose dolphin, common dolphin, harbour porpoise, minke whale, Risso's dolphin, white-beaked dolphin and white-sided dolphin). The boundaries of the MUs for each species are primarily defined by the presence of known populations, with divisions proposed on the basis of ecological evidence and / or divisions used for the management of human activities. MUs provide an indication of the spatial scales at which impacts of plans and projects need to be assessed for the key cetacean species in UK waters (IAMMWG, 2021). The MUs within which the proposed Victory development area is located (see Figure 4.21), along with the corresponding abundance of animals within these units, are presented in Table 4.19.

Table 4.19: Marine Mammal Management Units for Cetaceans in UK Waters (IAMMWG, 2021)

Species	Management Unit (MU)	Abundance in MU	Abundance in UK part of MU	Density[1]
Harbour porpoise	North Sea ($678,206\ km^2$)	346,601	159,632	0.5
Bottlenose dolphin	Greater North Sea ($639,886\ km^2$)	2,022	1,885	0.003
Risso's dolphin	Celtic and Greater North Seas ($1,560,875\ km^2$)	12,262	8,687	0.007
Common dolphin		102,656	57,417	0.06
Minke whale		20,118	10,288	0.01
White-beaked dolphin		43,951	34,025	0.02
White-sided dolphin		18,128	12,293	0.01

[1]Density (individuals per km^2) was calculated using the total area of the MU and the abundance of animals within that MU

All species of cetacean are listed as European Protected Species (listed in Annex IV of the EC Habitats Directive) and the harbour porpoise and bottlenose dolphin are listed under Annex II of the EC Habitats Directive, a status that obliges member states to afford protection to species and habitats through the designation of Special Areas of Conservation (SACs). In addition, all cetacean species are listed as PMFs in Scottish waters (SNH, 2014; Tyler-Walters *et al.*, 2016) and the minke whale, Risso's dolphin and white-beaked dolphin are also listed as MPA search features in Scottish waters (Tyler-Walters *et al.,* 2012) however all of these three species are regarded as being of 'Least Concern' in terms of their population threats and global conservation status (IUCN, 2021). Note, there are no marine protected areas designated for the protection of cetaceans in the vicinity of the proposed Victory development area.

Of the cetacean species mentioned, there has been a change in overall conservation status from favourable to unknown since 2013. This is due to the implementation of a more robust assessment methodology, supported by updated EU Commission guidance, which requires consideration of population trends in setting the Favourable Reference Population (FRP) value. However, this requires a higher number of UK population estimates over time than are currently available, resulting in the unknown conclusion (OPRED, 2022).

Figure 4.20: SCANS III Blocks in the Vicinity of the Proposed Victory Development

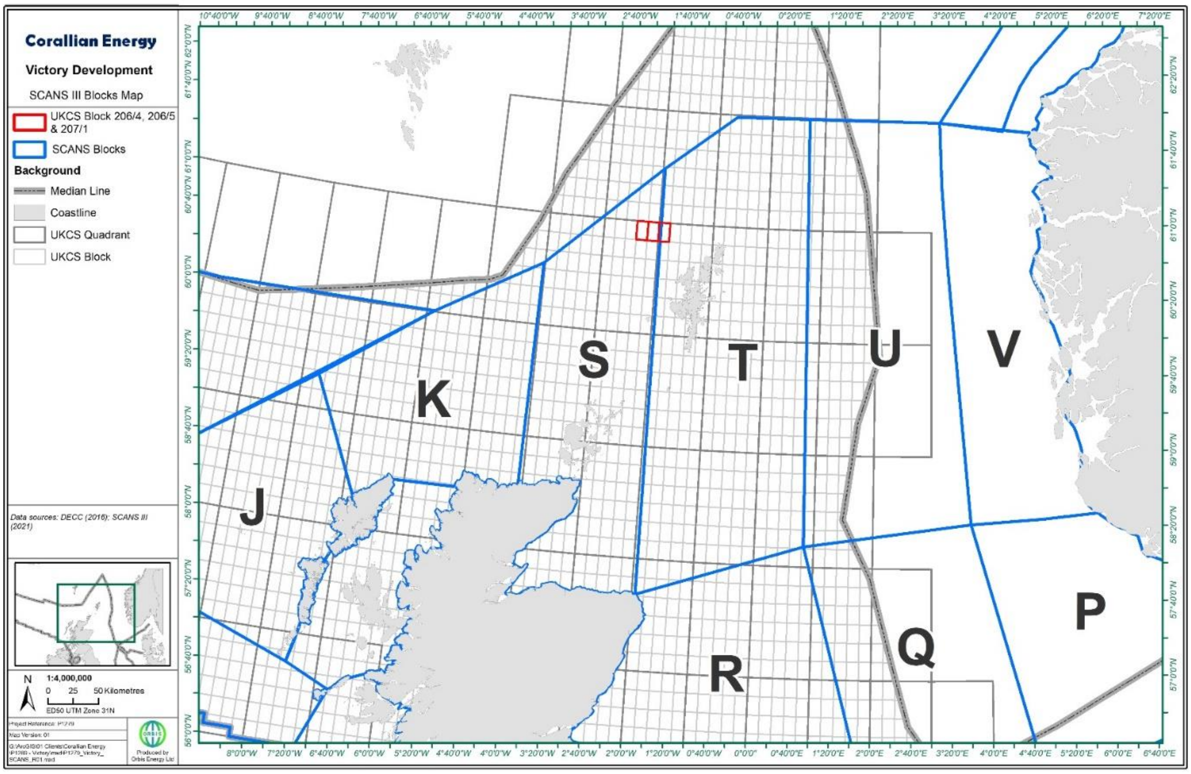
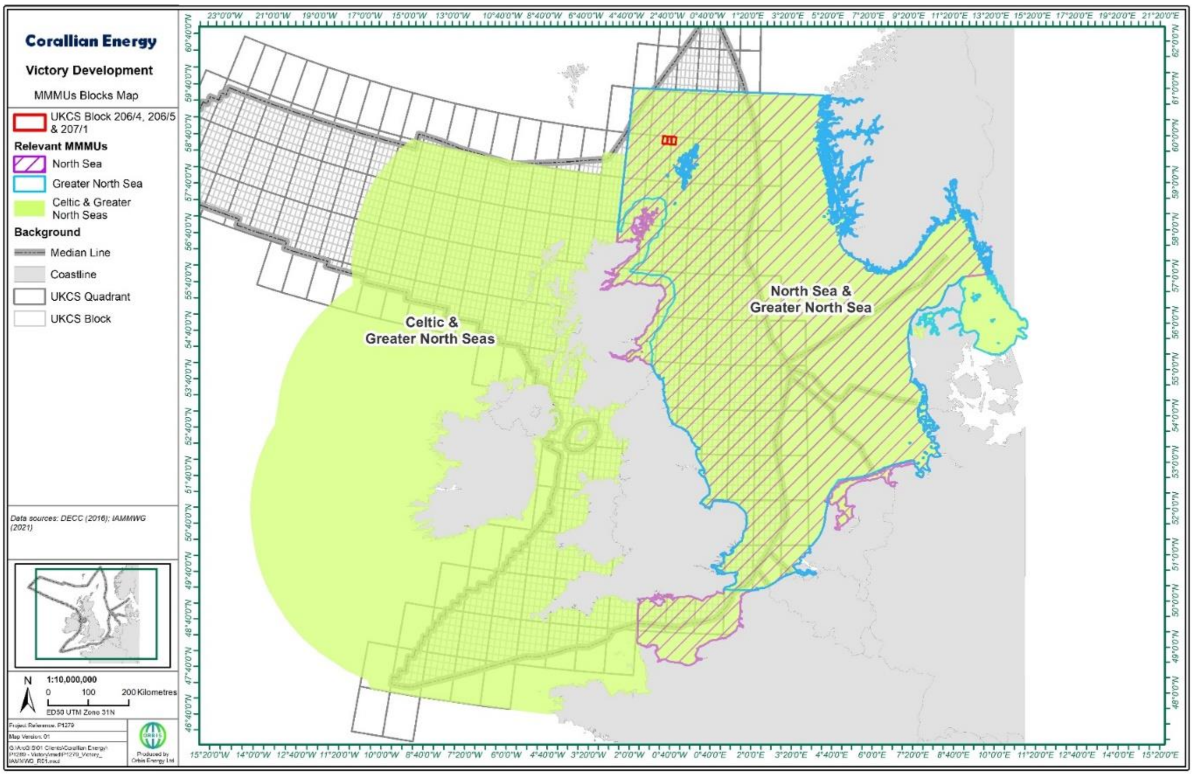


Figure 4.21: MMMUs Blocks in the Vicinity of the Proposed Victory Development



Seals

Two species of seal (pinniped) are resident in Scottish waters, the grey seal (*Halichoerus grypus*) and the harbour, or common, seal (*Phoca vitulina*). These animals are most frequently found in coastal waters less than 200 m deep and are present in internationally important numbers around the Shetland Islands (DECC, 2016). Grey and harbour seals are both listed under Annex II of the EU Habitats Directive, requiring the designation of SACs in order to protect these species. In addition, harbour and grey seals are protected under the Conservation of Seals Act 1970 (from 0 - 12 nautical miles from the coast) and both the harbour and grey seal are listed as PMFs to aid in their conservation in Scottish waters (SNH, 2014; Tyler-Walters *et al*., 2016). The Protection of Seals (Designated Seal Haul-out Sites) (Scotland) Order 2014 also introduced additional protection for seals at 194 coastal locations where seals come ashore to rest, moult or breed.

Grey Seals

Approximately 38% of the global grey seal population breed in the UK and 88 % of these breed at colonies in Scotland with the main concentrations in the Outer Hebrides and in Orkney. There are also breeding colonies in Shetland (SCOS, 2019). They utilise outlying islands and remote coastlines as moulting, pupping and haul-out sites. The Orkney Islands support the second largest breeding colony for grey seals in the UK at the Faray and Holm of Faray Islands in the northern part of Orkney, located approximately 195 km to the south east of the proposed Victory development area. Around the Scottish Continental Shelf region, studies have shown that grey seals tend to utilise much of the coastal shelf seas, with greatest activity around Orkney, Shetland, North Rona, the north mainland and west and south of the Outer Hebrides; activity in these areas represents some of the highest in UK waters (Jones *et al*., 2015; DECC, 2016).

Grey seals spend a high proportion of their time ashore during their annual moult (December to April) and during the breeding (autumn) and pupping seasons. The majority of grey seals in west Scotland pup between September and late November (SCOS, 2019). Satellite tracking has shown that grey seals may forage up to several hundred kilometres offshore, although most foraging probably occurs within 100 km of their haul out site (SCOS, 2019). Individual seals based at a particular haul-out site will also often make repeated trips to the same locations offshore (SCOS, 2019). The closets pupping site to the proposed Victory well is at Uyea on the northwest coast of the Shetland Island, located approximately 46 km to the southeast (Marine Scotland, 2021a).

Grey seals were rarely sighted in waters near the shelf edge during JNCC surveys of seabird and marine mammal distribution (Pollock *et al*., 2000). Tracking studies also indicate the at-sea distribution of grey seals around the Victory development area is generally low (less than five individuals per 25 square kilometres) (Figure 4.22; Russel *et al.,* 2017).

Harbour Seals

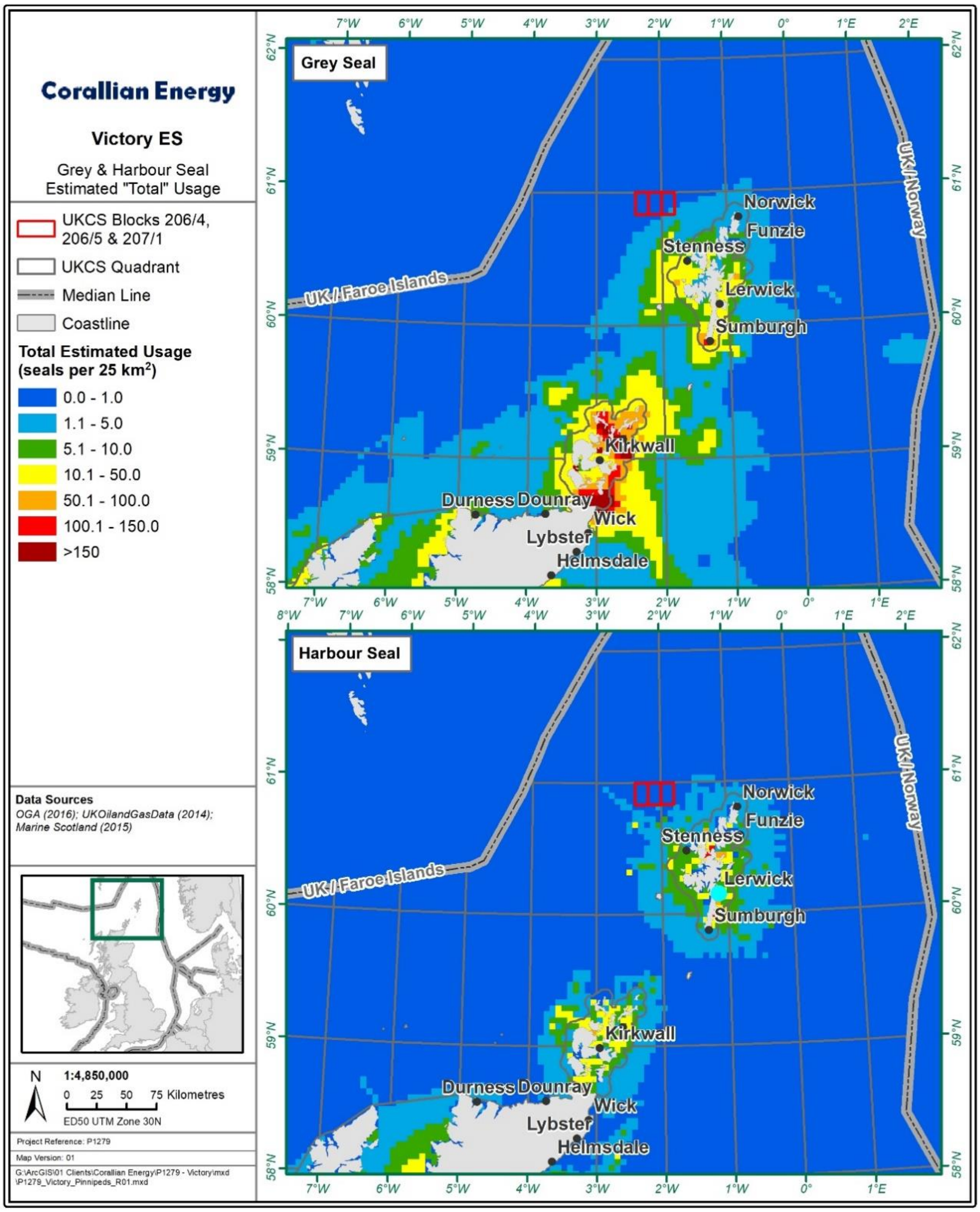
The UK is home to approximately 30% of the European population of harbour seals, with Scotland holding approximately 79% of the UK harbour seal population (SCOS, 2019). Harbour seals are widespread around the west coast of Scotland, throughout the Hebrides and around Shetland and Orkney (SCOS, 2019; DECC, 2016), although major declines have been documented in many harbour seal populations around Scotland, with declines of 85% between 1993 and 2019 seen in Shetland (Morris, 2021).

Harbour seal haul out, breeding and moulting sites are typically situated in sheltered estuaries and on sandbanks, but they also utilise rocky areas. Harbour seal populations on Shetland are concentrated along the Yell Sound coast, St Magnus Bay and on the island of Mousa (Duck, 1997; JNCC, 2021) and the Yell Sound Coast SAC, partly designated for the protection of harbour seal, is located approximately 46 km south east of the proposed Victory development area.

Harbour seals spend a high proportion of time ashore during the pupping and moulting seasons from June to August (Hammond *et al.,* 2001). Satellite tagging studies have observed that foraging trips around Orkney and Shetland are generally within 40 - 50 km of haul out sites; some foraging trips of over 100 km were recorded (SCOS, 2005; SCOS, 2014). Longer trips (further than 200 km) were also observed, but these were between haul out sites on Orkney and Shetland rather than to offshore foraging areas.

As with grey seals, harbour seals were rarely sighted in deeper waters near the shelf edge during coordinated JNCC surveys (Pollock *et al.,* 2000). Tracking studies also indicate the at-sea distribution of harbour seals around the Victory development area is generally very low (less than one individual per 25 square kilometres) (Figure 4.12; Russel *et al.,* 2017).

Figure 4.22: Estimated Grey and Harbour Seal Total Usage (at sea and hauled out) around the Proposed Victory Development



Management Units for Seals

The UK SNCBs have also defined MUs for grey and harbour seals in inshore UK waters in order to provide an understanding of the geographical range and abundance of their populations, and subpopulations to aid conservation and management purposes. Each species possesses a number of MUs depending on its spatial distribution, habitat use and environmental pressures. The proposed Victory development area is located within the Shetland MU (IAMMWG, 2013). Table 4.20 lists the seal count and estimated populations within this unit.

Table 4.20: Estimates of Seal Abundance in the Relevant MU

Species	Management Unit	Seal Count	Estimated Population Size [1]	Survey Year
Grey seal	Shetland	1,536	5,100	2009
Harbour seal	Shetland	3,039	-	2009

[1] An independent population estimate for grey seals was calculated using counts obtained during the 2007 and 2008 summer surveys (Lonergan *et al*., 2010). Please note, these estimates were not available for harbour seals.

In the UK, recent demographic changes (increases in most grey seal populations and declines in some harbour seal populations) could potentially be linked in some way to climate-mediated changes in food supply, however, other factors (depletion of food resources from fishing, recovery from epizootics, interspecific competition, density dependent effects) may be more important (OPRED, 2022).

Otters

The otter (*Lutra lutra*) is a semi-aquatic mammal, which occurs in both inland freshwater and coastal waters (JNCC, 2017). The Scottish population comprises a high proportion of coastal-dwelling individuals that feed almost exclusively in the sea. The coast and islands of western Scotland are particularly important for this species (SNH, 2021). However, otters do not venture far offshore as while they utilise shallow inshore marine areas for feeding they also require freshwater for bathing and terrestrial areas for resting and breeding (JNCC, 2017). This species is therefore not likely to be present in the vicinity of the proposed Victory development area.

Otters are listed as an EPS (European Protected Species) (listed in Annex IV of the EC Habitats Directive) and in Annex II of the EC Habitats Directive, a status that obliges member states to afford protection to species and habitats through the designation of Special Areas of Conservation (SACs). Otters are also listed as a PMF in Scottish terrestrial waters (SNH, 2014*;* Tyler-Walters *et al*., 2016) and are listed as ‘Near Threatened’ in terms of their population threats and global conservation status (IUCN, 2021).

4.3.6 Marine Protected Areas

Marine protected areas (MPAs) in the vicinity of the proposed Victory development area, including those along the coastline of the Shetland Islands adjacent to the proposed development area, are shown in Figure 4.23 and discussed below.

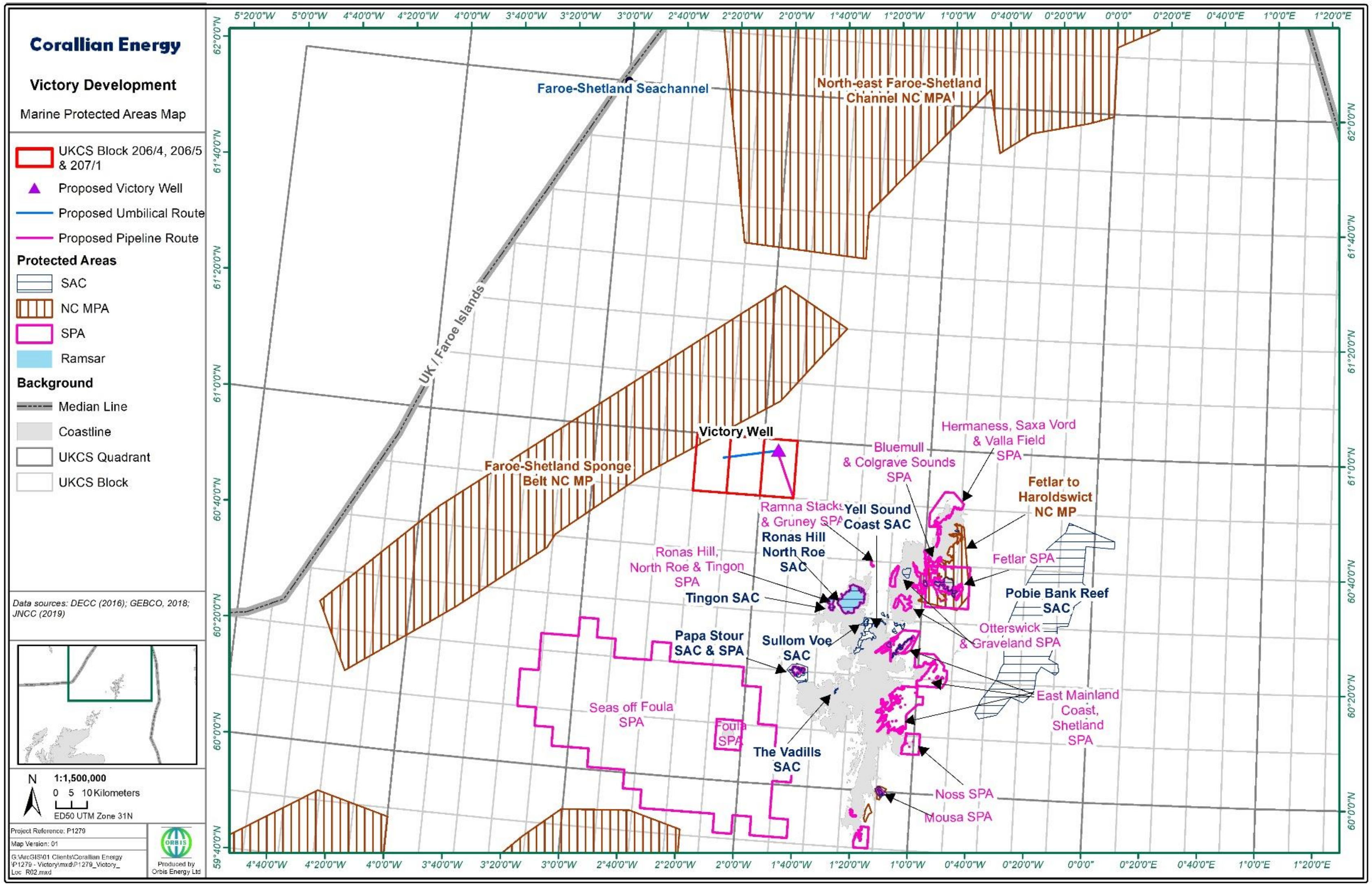
Faroe-Shetland Sponge Belt NC MPA

The nearest MPA to the proposed Victory development area is the Faroe-Shetland Sponge Belt Nature Conservation Marine Protected Areas (NC MPA), which lies approximately 8 km to the north east of the Edradour manifold location at its closest point. This NC MPA is designated for the protection of nine features of conservation interest:

- Deep sea sponge aggregations;
- Ocean quahog (*Arctica islandica*) aggregations;
- Atlantic and Arctic influenced offshore subtidal sand and gravel habitats;
- An area of the Faroe-Shetland Channel continental slope; and

- Five geodiversity (geomorphological) features representative of the West Shetland Margin paleo-depositional system and the West Shetland Margin Contourite Deposits key geodiversity areas (JNCC, 2014b).

Figure 4.23: Marine Protected Areas in the Vicinity of the Proposed Victory Development



The sponge aggregations provide shelter for a diverse faunal assemblage and an elevated substratum to allow filter and suspension feeders to extend into the water column to feed (JNCC, 2014b). Deep-sea sponge aggregations and the ocean quahog are on the OSPAR List of Threatened and / or Declining Species and Habitats (OSPAR, 2016). These, along with Atlantic and Arctic influenced offshore subtidal sand and gravel habitats, are also listed as PMFs (SNH, 2014; Tyler-Walters *et al*., 2016).

The Faroe-Shetland Sponge Belt NC MPA is entirely located beyond the shelf break in waters deeper than 400 m. The sponge communities present are believed to be restricted to between 400 - 600 m on the slope (JNCC, 2014b). Within the site, the boreal ostur aggregation is formed by massive sponges including, *Geodia barretti*, *G. macandrewi*, *G. atlantica* and *G. phlegraei* (Henry and Roberts, 2014). The flabellate chalice sponge (*Phakellia ventilabrum*) was also observed during the survey of the site in 2012. Other erect sponges, and yellow and white encrusting sponges, are also present in the aggregation (Howell *et al.,* 2010). As noted in Section 4.3.2, no deep-sea sponge aggregation were observed during the Victory survey (BSL, 2021b).

The ocean quahog is a large burrowing bivalve found buried in sandy and muddy sediments in water depths between 10 – 280 metres, although it may be found in waters as deep as 480 metres (Tyler-Walters *et al*., 2016). The ocean quahog is considered to be the longest living mollusc, with one individual reported as being over 500 years in age (Tyler-Walters *et al*., 2016). Ocean quahog has been found in a range of sediments, from coarse clean sand to muddy sand in a range of depths typically from 4 m to 482 m deep, but most commonly between 10 m to 280 m (Thorarinsdóttir and Einarsson, 1996; Sabatini *et al*., 2008; OSPAR, 2009; Tyler-Walters and Sabatini, 2017). Ocean quahog is thought to have a high sensitivity to physical loss of habitat (Tyler-Walters and Sabatini, 2017). It is therefore important to conserve the extent and distribution of supporting habitats to provide the best chance of any potential settlement for new recruits and to retain existing individuals. However, as noted in Section 4.3.2, no individuals were recorded in the macrofauna data at Victory, no potential relict shells were observed along video transects and no live individuals or their distinctive siphons were noted during analysis of video footage and still photographs from the survey area (BSL, 2021b).

The interaction between hydrographic processes and the continental slope may enhance feeding conditions through the aggregation of principle prey items (e.g. squid, herring, blue whiting and krill) for several species of cetacean, including sperm whale, minke whale, killer whale, fin whale, long-finned pilot whale and Atlantic white-sided dolphin (Stone, 1988; Weir *et al.,* 2001; Swift *et al.,* 2002; Macleod, 2004; Macleod *et al.,* 2006). In addition, the topography of the Faroe-Shetland Channel continental slope and wider channel is thought to be of functional significance as a migratory pathway/corridor for several cetacean species (refer to Section 4.3.5 for further details).

The conservation objective for the Faroe-Shetland Sponge Belt NC MPA is that the protected features listed above, so far as already in favourable condition, remain in such condition; and so far as not already in favourable condition, be brought into such condition, and remain in such condition (JNCC, 2018).

Coastal MPAs

The next closest protected areas with marine components are all located along the coastline of the Shetland Islands, adjacent to the proposed Victory development area. The Shetland Islands possess a highly indented coastline with sheltered inlets as well as very exposed headlands. The resulting habitats are therefore highly heterogeneous and include extensive stretches of exposed cliffs and rocky shorelines with long, narrow inlets (known locally as voes) extending several kilometres inland. Sandy shorelines are rare and are largely restricted to sheltered embayments. In some of sheltered areas, small lagoons have become impounded behind shingle or gravel sand bars providing habitats such as salt marsh (DECC, 2016).

Coastal MPAs closest to the proposed Victory development area include:

- **Ramna Stacks and Gruney SPA** located 33 km south east of the proposed Victory development area. This site qualifies under Article 4.1 by supporting populations of Leach's petrel in the breeding season. The conservation objectives for this site are:

1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
2. To ensure for the qualifying species that the following are maintained in the long term:
    a. Population of the species as a viable component of the site.
    b. Distribution of the species within site.
    c. Distribution and extent of habitats supporting the species.
    d. Structure, function and supporting processes of habitats supporting the species.
    e. No significant disturbance of the species.

- **Ronas Hill - North Roe and Tingon SPA and Ramsar site** located approximately 34 km south east of the proposed Victory development area. This site qualifies under Article 4.1 and Article 4.2 of the Birds Directive by supporting populations of European importance of red-throated diver and merlin (JNCC, 2021d). Although not qualifying features, the site also provides habitat for harbour seal and otter. The conservation objectives for this site are:

1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
2. To ensure for the qualifying species that the following are maintained in the long term:
    a. Population of the species as a viable component of the site.
    b. Distribution of the species within site.
    c. Distribution and extent of habitats supporting the species.
    d. Structure, function and supporting processes of habitats supporting the species.
    e. No significant disturbance of the species.

- **Otterswick and Gravesland SPA** located 39 km south east of the proposed Victory development. This site qualifies under Article 4.1 by supporting populations of red-throated diver. The conservation objectives for this site are:

1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
2. To ensure for the qualifying species that the following are maintained in the long term:
    a. Population of the species as a viable component of the site.
    b. Distribution of the species within site.
    c. Distribution and extent of habitats supporting the species.
    d. Structure, function and supporting processes of habitats supporting the species.
    e. No significant disturbance of the species.

- **Hermaness, Saxa Vord and Valla Field SPA** located approximately 43 km east of the proposed Victory development area. This site is located on the northernmost tip of Shetland and qualifies under Article 4.1 and Article 4.2 of the Birds Directive by supporting populations of European importance (refer to Section 4.3.4). It also qualifies under Article 4.2 by regularly supporting an assemblage of over 20,000 birds (JNCC, 2021d).

1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
2. To ensure for the qualifying species that the following are maintained in the long term:
    a. Population of the species as a viable component of the site.
    b. Distribution of the species within site.
    c. Distribution and extent of habitats supporting the species.
    d. Structure, function and supporting processes of habitats supporting the species.
    e. No significant disturbance of the species.

- **Bluemull and Colgrave Sounds SPA** located 46 km south east of the proposed Victory development area. This site qualifies under Article 4.1 by supporting populations of red-throated diver. The conservation objectives for this site are:

1. To ensure that red-throated diver at Bluemull and Colgrave Sounds SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status.

2. To ensure that the integrity of Bluemull and Colgrave Sounds SPA is maintained in the context of environmental changes by meeting objectives 2a, 2b and 2c for red-throated diver:
    a. The population of red-throated diver is a viable component of the site.
    b. The distribution of red-throated diver throughout the site is maintained by avoiding significant disturbance of the species.
    c. The supporting habitats and processes relevant to red-throated diver and their prey/food resources are maintained.

- **Yell Sound Coast SAC** located approximately 46 km south east of the proposed Victory development area. The site is designate for Annex II species harbour seal and otter. The conservation objectives for the site are:

1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
2. To ensure for the qualifying species that the following are maintained in the long term:
    a. Population of the species as a viable component of the site.
    b. Distribution of the species within site.
    c. Distribution and extent of habitats supporting the species.
    d. Structure, function and supporting processes of habitats supporting the species.
    e. No significant disturbance of the species.

- **Fetlar SPA** located approximately 47 km south east of the proposed Victory development area. The site qualifies under Article 4.1 by regularly supporting populations of red-necked phalarope and Arctic tern, and under Article 4.2 by regularly supporting populations of whimbrel, great skua and dunlin. The SPA also regularly supports in excess of 20,000 individual seabirds. The conservation objectives for this site are:

1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
2. To ensure for the qualifying species that the following are maintained in the long term:
    a. Population of the species as a viable component of the site.
    b. Distribution of the species within site.
    c. Distribution and extent of habitats supporting the species.
    d. Structure, function and supporting processes of habitats supporting the species.
    e. No significant disturbance of the species.

- **Sullom Voe SAC** is located approximately 47 km south east of the proposed Victory development area. This site is designated due to the presence of Annex I large shallow inlets and bay. Annex I habitats present as a qualifying feature, but not a primary reason for selection of this site include reef and coastal lagoons. The conservation objectives for the site are:

1. To avoid deterioration of the qualifying habitats thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying features;
2. To ensure for the qualifying habitats that the following are maintained in the long term:
    a. Extent of the habitat on site:
    b. Distribution of the habitat within site
    c. Structure and function of the habitat
    d. Processes supporting the habitat
    e. Distribution of typical species of the habitat
    f. Viability of typical species as components of the habitat
    g. No significant disturbance of typical species of the habitat

- **Fetlar to Haroldswick NC MPA** located 53 km south east of the proposed Victory development area. The site supports populations of black guillemot in the breeding season. The conservation objective for this site aims to conserve the protected features in order to make a long lasting contribution to the MPA network.

- **Papa Stour SPA and SAC** located 54 km south east of the proposed Victory development area. This site qualifies under Article 4.1 and Article 4.2 of the Birds Directive by supporting populations of European importance (refer to Section 4.3.4; JNCC, 2021d). This site is also designated as an SAC due to the presence of Annex I reefs and submerged or partially submerged sea caves (JNCC, 2021d). The conservation objectives for the SPA are:
  1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained;
  2. To ensure for the qualifying species that the following are maintained in the long term:
  a. Population of the species as a viable component of the site;
  b. Distribution of the species within site;
  c. Distribution and extent of habitats supporting the species;
  d. Structure, function and supporting processes of habitats supporting the species;
  e. No significant disturbance of the species.

  The conservation objectives for the SAC are:

  1. To avoid deterioration of the qualifying thus ensuring that the integrity of the site is maintained and the site makes an appropriate contribution to achieving favourable conservation status for each of the qualifying interests.
  2. To ensure for the qualifying habitats that the following are maintained in the long term:
     a. Extent of the habitat on site:
     b. Distribution of the habitat within site
     c. Structure and function of the habitat
     d. Processes supporting the habitat
     e. Distribution of typical species of the habitat
     f. Viability of typical species as components of the habitat
     g. No significant disturbance of typical species of the habitat

Seas off Foula SPA

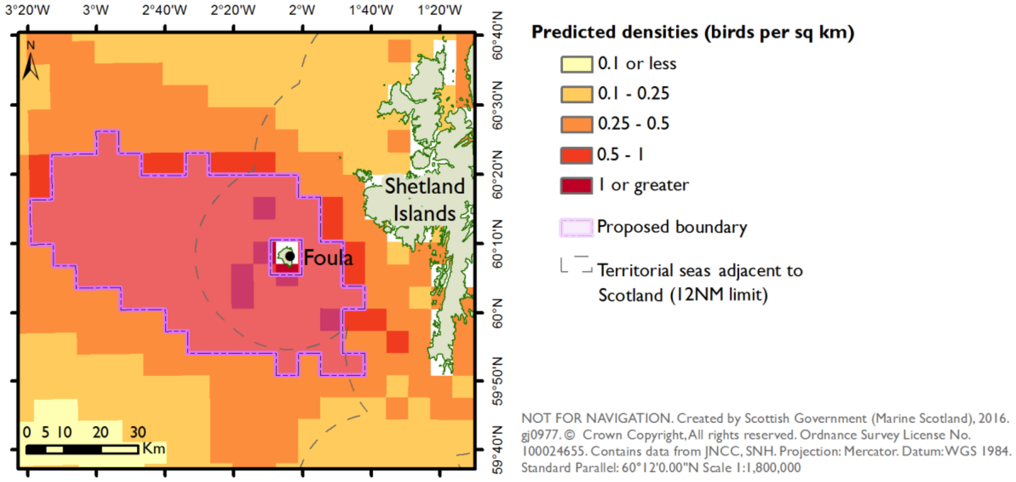
Further offshore is the Seas off Foula SPA located approximately 57 km to the south west of the proposed Victory development area. The Seas off Foula SPA covers the waters around and to the north west of the Isle of Foula and is located 15 km west of mainland Shetland. Seabirds breeding on Foula are already protected on land and in the waters immediately surrounding the island by the existing Foula SPA. The Seas off Foula SPA provides additional protection for seabirds in the area by ensuring that the adjacent marine foraging habitat and the prey on which seabirds depend are equally protected (JNCC, 2021).

Specifically, the SPA protects the following migratory seabird species that forage at sea: Great skua (breeding and non-breeding); assemblage of breeding seabirds; assemblage of seabirds, non-breeding; including northern fulmar (breeding and non-breeding); Arctic skua (breeding); common guillemot (breeding and non-breeding) and Atlantic puffin (breeding). The seaward boundary of the site is based on the extent of the sea area around Foula that holds at least 1 % of the biogeographic population of great skua on a regular basis (see Figure 4.24), however, all of the qualifying seabird species are found throughout the entire extent of the Seas off Foula SPA (JNCC, 2016a). The conservation objectives for this site are:

- Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term;
- Maintain the habitats and food resources of the qualifying features in favourable condition.

Studies suggest that the site, at least in its southern extent (Coull *et al*., 1998; Ellis *et al.,* 2012), overlaps with spawning and nursery grounds of sandeels. Sandeels are an important prey resource for many seabird species, particularly in the Seas off Foula SPA, the maintenance of both sandeel habitat and associated populations is important in order to ensure the ability of the site to support the qualifying species in the long-term (JNCC, 2016a).

Figure 4.24: Predicted at Sea Densities of Great Skua and the Boundary of Seas off Foula (JNCC, 2016a)



North-east Faroe-Shetland Channel NC MPA

The North-east Faroe-Shetland Channel NC MPA is located approximately 64 km to the north of the proposed Victory development area. The NC MPA has been designated for the protection of deep-sea sponge aggregations, offshore deep-sea muds, offshore subtidal sands and gravels, continental slope and features representative of the West Shetland Margin Palaeo-depositional, Miller Slide and Pilot Whale Diapirs Key Geodiversity Areas. The site covers a large proportion of the north-eastern reaches of the Faroe-Shetland Channel in Scottish waters. The continental slope contributes to funnelling oceans currents which bring food and nutrients which support a wide diversity of life in the region. The slope additionally acts as corridor for migratory marine mammals including the fin whale (and sperm whale, as described in Section 4.3.5 (JNCC, 2021c). The conservation objectives for the North-East Faroe-Shetland Channel Nature Conservation Marine Protected Area are that the protected features so far as already in favourable condition, remain in such condition; and so far as not already in favourable condition, be brought into such condition, and remain in such condition.

4.4 Human Environment

4.4.1 Commercial Fisheries

The seas of the Scottish continental shelf region are heavily fished by both the UK fleet and foreign vessels (DECC, 2016). In the UK, virtually all commercially fished species are heavily exploited although there is some evidence of recovery for some stocks (OPRED, 2022). Fishing effort and landings around the UK is recorded by ICES statistical rectangle; however these data only record effort and landings from UK vessels. A number of international vessels, such as those from Denmark, Germany, France, Russia and Belgium are also active in the area, some of which can be larger than the Scottish fleet (SFF, 2015). The proposed Victory development area lies within ICES Rectangles 50E7 and 50E8. The landings data and fishing effort data for Rectangles 50E7 and 50E8 has been provided by Marine Scotland for the period 2016 to 2020 (the 2020 data used is provisional data) and is discussed in the proceeding sections (Marine Scotland, 2021b).

Fishing Effort

Between 2016 and 2020 the mean annual fishing effort, by UK vessels over 10 metres in length, in the vicinity of the proposed Victory development was 472 days (Marine Scotland, 2021). The highest annual fishing effort was recorded in 2018 (780 days) and the lowest fishing effort was recorded in 2017 (208 days) (Marine Scotland, 2021b). Average monthly fishing effort between 2016 and 2020 in ICES Rectangle 50E7 indicates that fishing effort tends to be highest between December and March, and in ICES Rectangle 50E8 fishing effort is highest between April and November (Table 4.21; Figure 4.25).

Figure 4.25: Total Monthly Fishing Effort (days) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 in ICES Rectangles 50E7 and 50E8

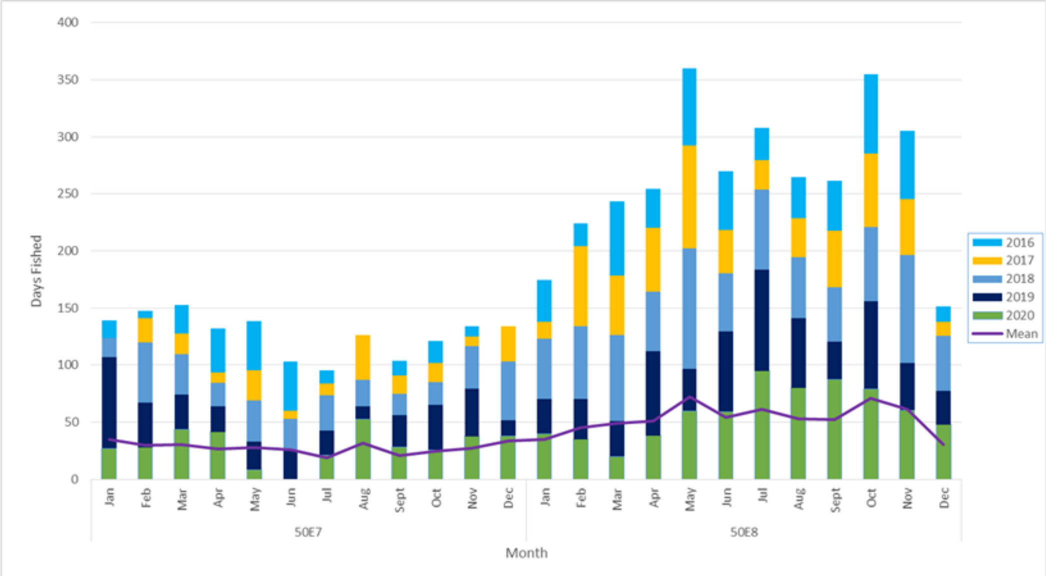


Table 4.21: Total Monthly Fishing Effort (days) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 in ICES Rectangles 50E7 and 50E8

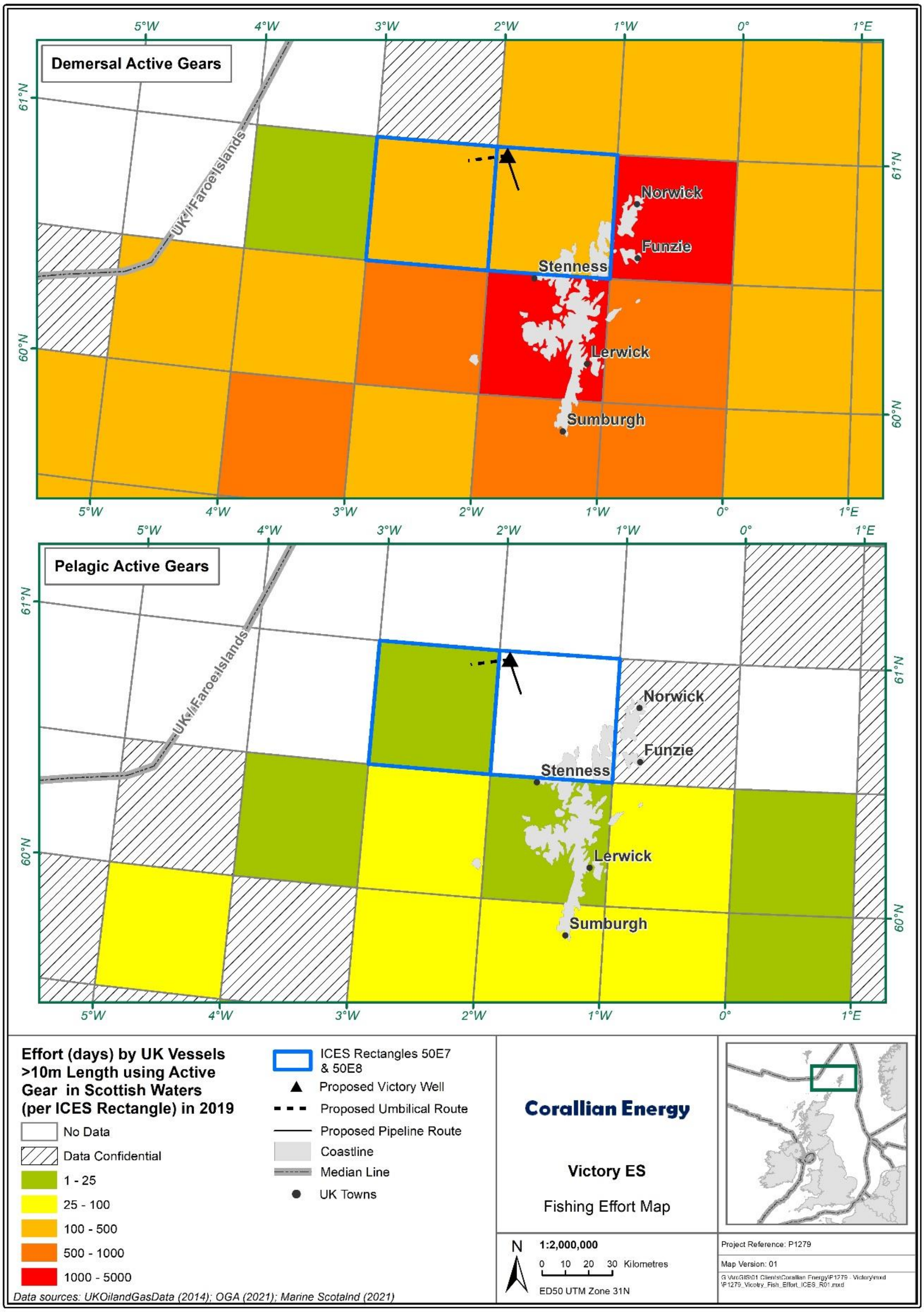
Month	50E7 - Fishing Effort (days)						50E8 - Fishing Effort (days)					
	2016	2017	2018	2019	2020	Mean	2016	2017	2018	2019	2020	Mean
Jan	16	-	17	80	27	35	37	15	53	30	40	35
Feb	6	21	53	39	28	30	20	70	64	35	35	45
Mar	25	18	35	31	44	31	65	52	75	31	20	49
Apr	38	9	21	23	41	26	34	56	52	74	38	51
May	44	26	36	25	8	28	67	90	105	37	60	72
Jun	43	7	27	26	-	26	51	38	51	70	59	54
Jul	11	10	31	21	21	19	28	26	70	89	95	62
Aug	-	39	23	11	53	31	36	34	54	61	80	53
Sept	13	16	19	28	28	21	44	50	47	33	87	52
Oct	19	17	20	40	26	24	70	64	65	77	79	71
Nov	9	9	37	41	38	27	60	49	95	41	60	61
Dec	-	31	51	14	38	33	13	13	48	29	48	30

Note: The blank values '-' represent disclosive data.

Between 2016 and 2020, fishing effort (in days) within ICES Rectangles 50E7 and 50E8 was dominated by gear falling into the category 'trawls' (71 %), followed by 'hooks and lines' (14 %) and 'dredges' (9 %) (Marine Scotland, 2021b).

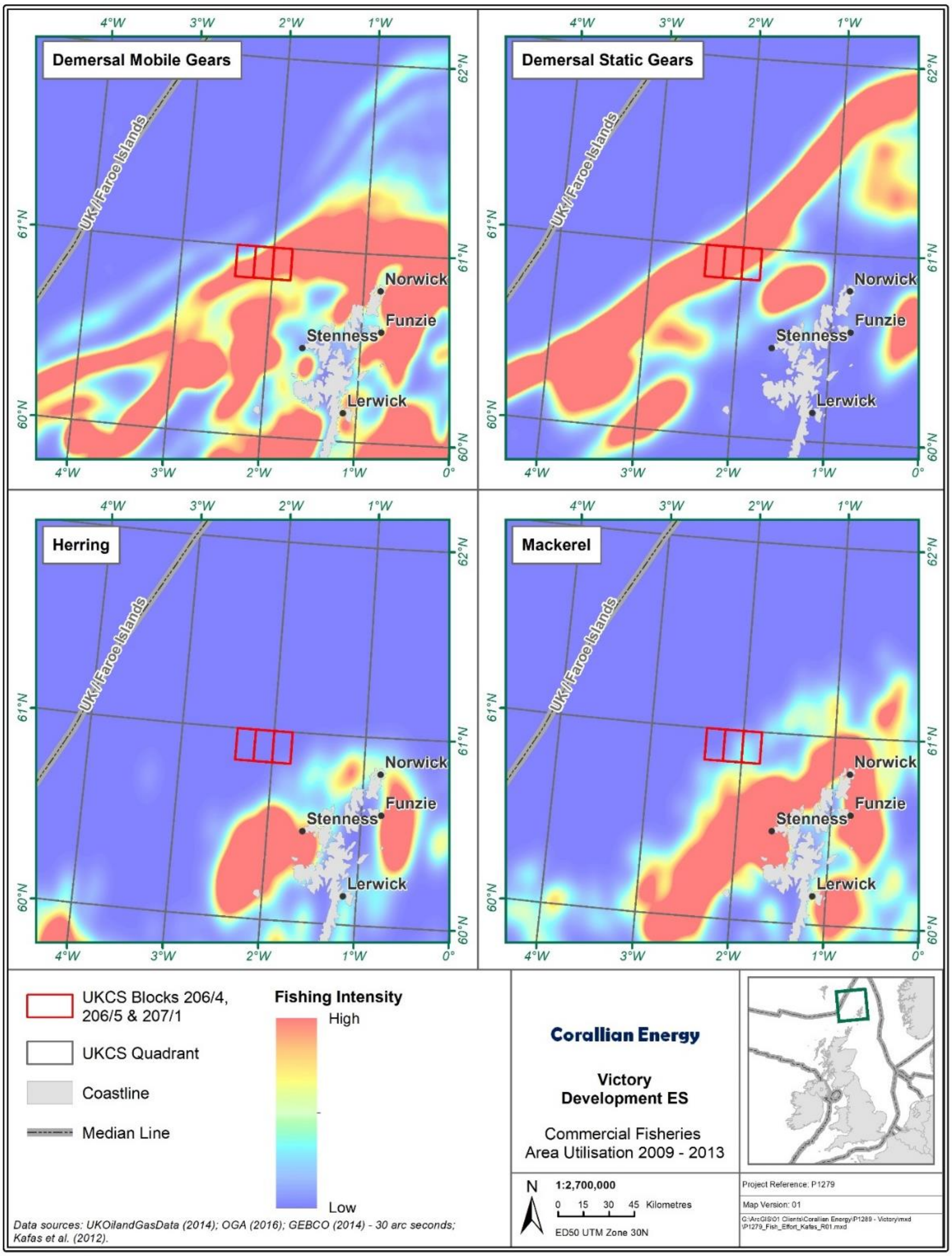
The latest fishing effort data provided by Marine Scotland (Marine Scotland, 2021b) and displayed in Figure 4.26 shows that UK vessels target demersal species within ICES Rectangles 50E7 and 50E8 and in the surrounding region.

Figure 4.26: Fishing Effort (days) by, UK Vessels over 10 Metres in Length, using Active Gear in Scottish Waters (per ICES Rectangle) in 2019



An analysis of fishing activity has also been undertaken by Kafas *et al*. (2012) using the Vessel Monitoring Systems (VMS). The VMS provides information on the locations and identity of all UK fishing vessels greater than 15 metres in length from 2009 to 2013. Fishing activity data from the VMS were combined with landings data to identify spatial patterns of fishing intensity. It is important to note that the data does not provide an absolute quantitative representation of the amount of fishing in an area, but can be used to qualitatively describe relative fishing intensity. Fishing intensity information was gathered for demersal mobile and demersal static gears, as well as pelagic fisheries (mackerel and herring). The demersal fishing effort was found to be high in the vicinity of the proposed Victory development, targeting species including saithe, monkfish, cod, ling and haddock. Whereas, the pelagic (mackerel and herring) fishing effort was found to be low to medium in the vicinity of the proposed Victory development; occurring at higher intensity towards the south and east, closer to shore (refer to Figure 4.27).

Figure 4.27: Utilisation of the Victory Development Area by Commercial Fisheries



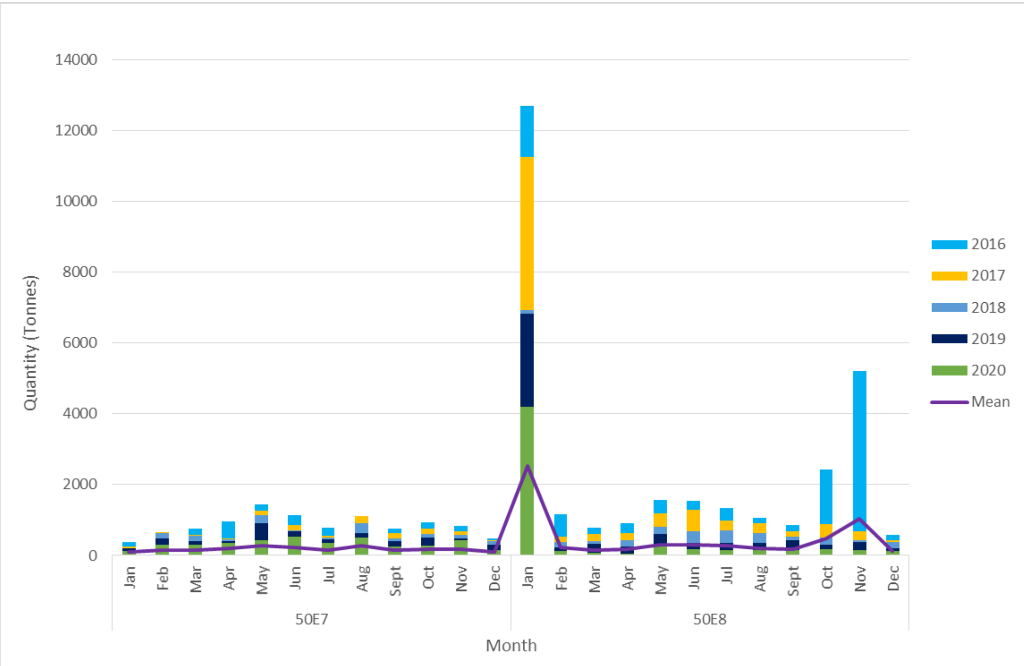
Fish Landings

Throughout the year, catches are relatively high within ICES Rectangles 50E7 and 50E8, but are consistently greater in the spring months in ICES Rectangle 50E7 and the winter months in ICES Rectangle 50E8. The average fish landings are greatest in May for ICES Rectangle 50E7 (289 tonnes) and in January in 50E8 (2539 tonnes) and lowest in January in ICES Rectangle 50E7 (93 tonnes) and in December in ICES Rectangle 50E8 (Table 4.22; Figure 4.28; Marine Scotland, 2021b).

Table 4.22: Total Monthly Fishing Landings (tonnes) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 within ICES Rectangles 50E7 and 50E8

Month	50E7 - Fishing Landings (tonnes)						50E8 - Fishing Landings (tonnes)					
	2016	2017	2018	2019	2020	Mean	2016	2017	2018	2019	2020	Mean
Jan	112	65	-	76	119	93	1439	4328	100	2627	4205	2539
Feb	-	7	161	164	303	159	631	153	152	102	114	230
Mar	182	29	133	100	311	151	181	223	52	260	80	159
Apr	485	18	47	64	343	192	261	214	172	211	47	181
May	188	119	221	490	429	289	383	376	200	374	240	315
Jun	274	140	39	151	527	226	266	591	332	189	172	310
Jul	220	58	40	108	350	155	346	275	365	195	150	266
Aug	-	208	270	138	505	280	154	266	272	224	140	211
Sept	135	150	63	170	245	153	180	150	100	296	141	173
Oct	178	141	108	219	278	185	1567	363	214	126	172	488
Nov	169	101	83	66	421	168	4509	258	58	229	146	1040
Dec	55	22	107	145	157	97	155	41	192	70	124	116

Figure 4.28: Total Monthly Fishing Landings (tonnes) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 within ICES Rectangles 50E7 and 50E8



Fish landings are comprised predominantly of pelagic species (average of 94 % contribution by weight and value) (Figure 4.29 and Figure 4.30). This is reflected by the dominant fishing gear types used in ICES Rectangle 50E7 and 50E8 which are trawls. Mackerel account for 66% of the annual catches by weight, followed by saithe, herring, monks or anglers and cod, and are therefore the dominant species targeted by the local fishery (see Table 4.23) (Marine Scotland, 2021b).

Table 4.23: Total Catch Composition by Weight (tonnes) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 within ICES Rectangles 50E7 and 50E8

Number	Average Quantity (tonnes)	Species
1	1,858.80	Mackerel
2	748.46	Saithe
3	617.36	Herring
4	426.81	Monks or Anglers
5	300.89	Cod
6	181.64	Hake
7	170.60	Ling
8	159.71	Haddock
9	126.06	Scallops
10	264.74	Other

Figure 4.29: Total Catch Composition by Weight (tonnes) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 within ICES Rectangles 50E7 and 50E8

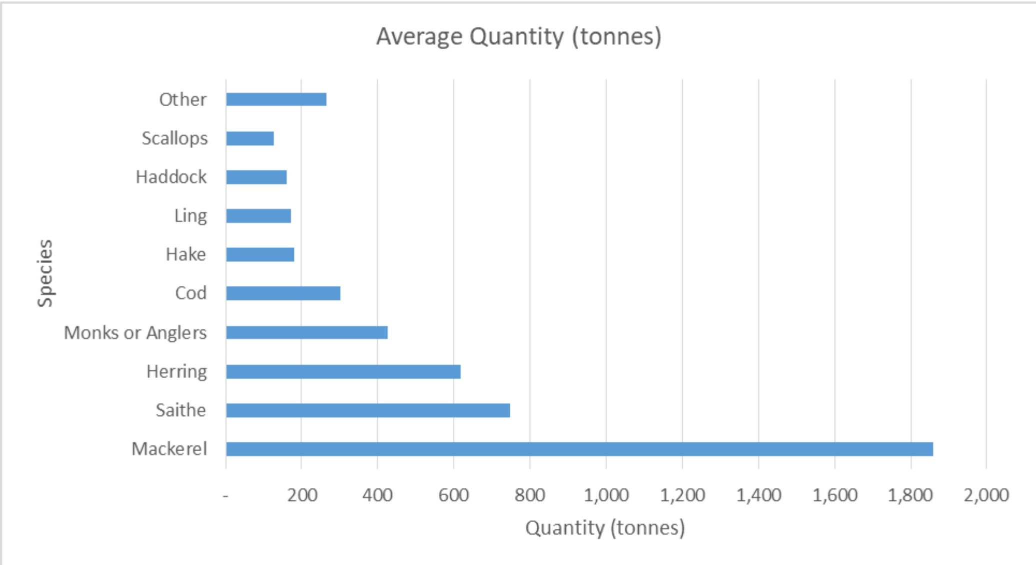
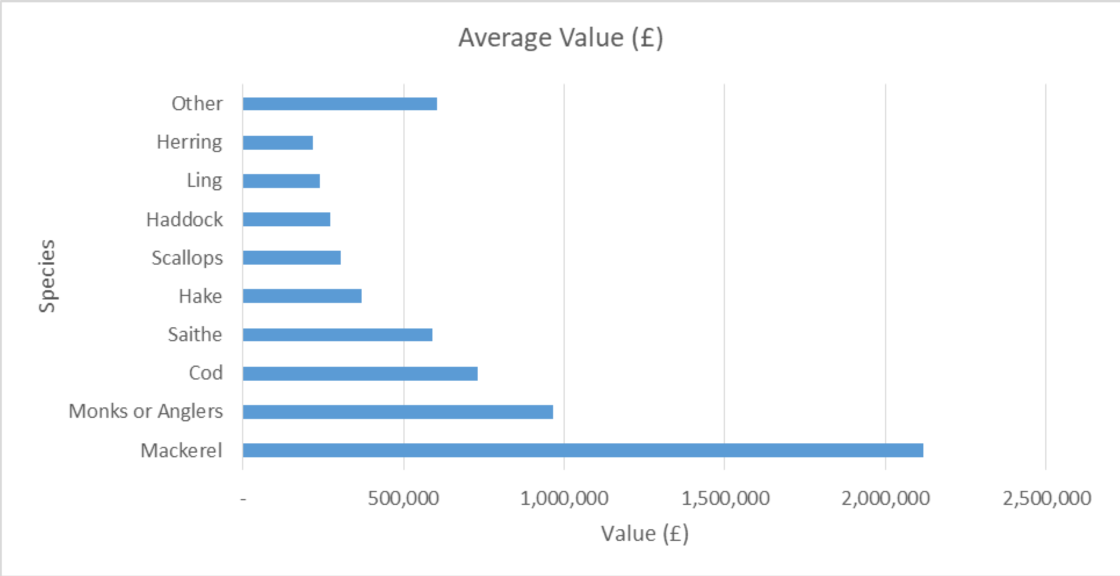


Figure 4.30 and Table 4.24 demonstrates that mackerel and monkfish are the greatest components of the fishery in terms of revenue generated in ICES Rectangles 50E7 and 50E8. Mackerel account for 33% (£2,117,729) and monkfish 15% of the revenue between 2016 and 2020 (Marine Scotland, 2021b).

Table 4.24: Total Catch Composition by Value (£) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 within ICES Rectangles 50E7 and 50E8

Number	Average Value (£)	Species
1	2,117,729.30	Mackerel
2	965,398.23	Monks or Anglers
3	730,893.96	Cod
4	590,953.24	Saithe
5	369,603.34	Hake
6	303,495.63	Scallops
7	273,490.88	Haddock
8	238,869.00	Ling
9	217,437.80	Herring
10	603,892.89	Other

Figure 4.30: Total Catch Composition by Value (£) by, UK Vessels over 10 Metres in Length, between 2016 and 2020 within ICES Rectangles 50E7 and 50E8



Mariculture

Mariculture is a prominent industry along the west coast of the Shetland Islands (Baxter *et al.,* 2011; Scotland's Aquaculture, 2021). Shetland produces approximately 18% of the total Scottish salmon and 79 % of the farmed mussels), although small volumes of oysters and scallops have also been produced in the past (Marine Scotland, 2021b). The closest mariculture area to the Victory development is the Hamnavoe shellfish aquaculture site, located approximately 54 km to the south east of the Victory development, which farms mussels (Marine Scotland, 2021b).

4.4.2 Shipping

Shipping activity in the waters to the West of Shetland are relatively low when compared with parts of the English Channel and North Sea (DECC, 2011b).

Commercial traffic is likely to include vessels en-route to/from Sullom Voe Terminal and vessels in transit across the Atlantic; these include containers, ferries and cruise liner traffic. The wide expanse of water, combined with overall low vessel traffic, result in reduced vessel congestion (DECC, 2009).

Within the proposed Victory development area; UKCS Blocks 207/1, 206/4 and 206/5, shipping densities are recorded as 'very low' (OGA, 2016a).

Average weekly density of all vessel types (tankers, recreational vessels, passenger vessels, military, port service craft and high speed craft) in the vicinity of the proposed Victory development area ranges from low (5 transits or less) to moderate (5-50 transits per week) as illustrated in Figure 4.31 (Marine Scotland, 2022). The average weekly density of fishing vessels ranges from moderate to high with approximately 10-50 transits per week as illustrated in Figure 4.32 (Marine Scotland, 2022).

Figure 4.31: Average weekly density of all vessel types 2012-2017 in the vicinity of the Victory Development Area (Marine Scotland, 2022)

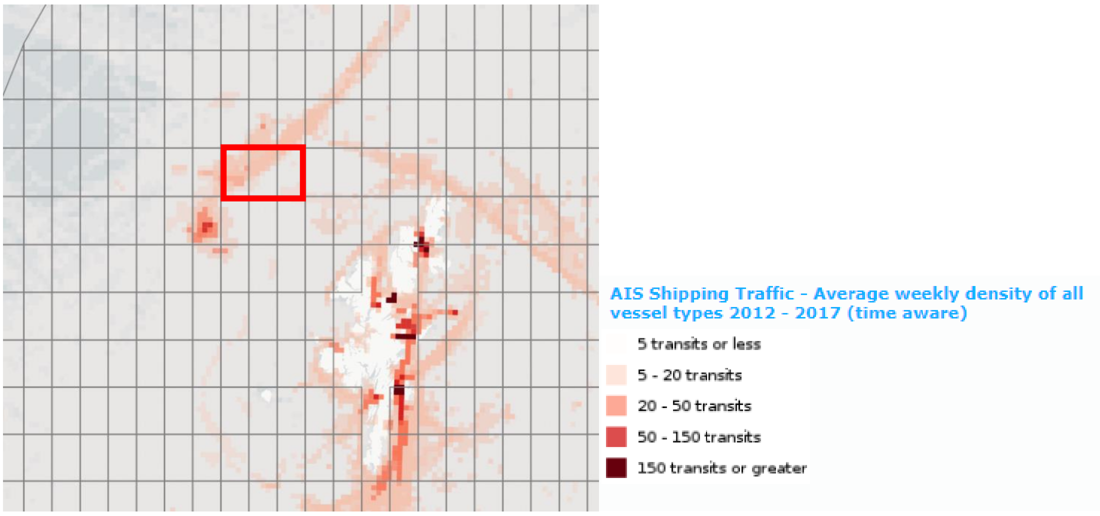
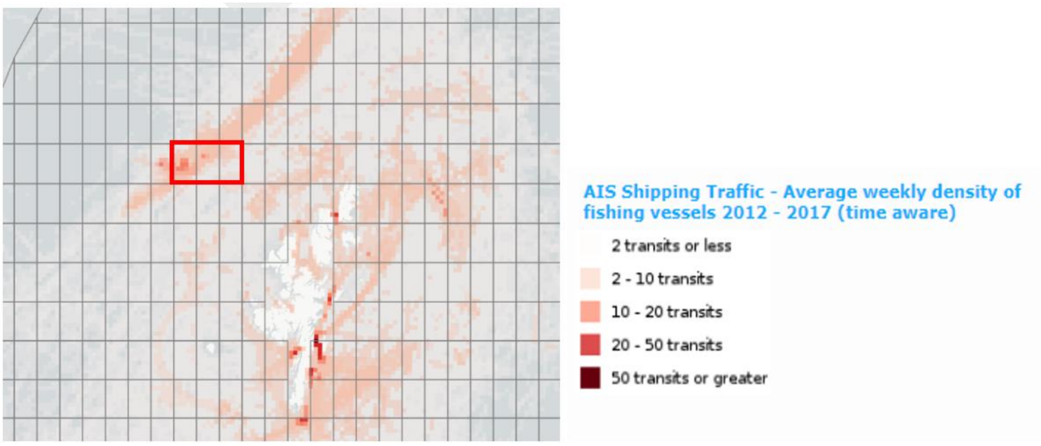


Figure 4.32: Average weekly density of fishing vessels 2012 - 2017 in the vicinity of the Victory Development Area



4.4.3 Offshore Energy and Submarine Cables

The proposed Victory well will tie back into the existing Greater Laggan Area (GLA) pipeline located approximately 17 km south east of Victory. The GLA pipeline is part of Total Energies 'West of Shetland' (WOS) operations, which includes the Laggan, Tormore, Edradour and Glenlivet fields (see Figure 4.33), and the Glendronach field located south of the Edradour field, which is in the development stage. The co-mingled fluids from these fields are transported via the GLA pipelines back to the Shetland Gas Plant (SGP) for processing and export (Total, 2019).

The closest surface oil and gas infrastructure to the proposed Victory development is the Clair Ridge platform located approximately 41 km south west of the proposed Victory well, followed by the Clair platform located approximately 45 km south west of the proposed Victory well. Both of these platforms are operated by BP (OGA, 2021b). A total of 16 wells have previously been drilled within UKCS Blocks 207/1, 206/4 and 206/5 (2 development, 3 appraisal, and 11 exploration). Of these, only one is currently listed as operating, one has been plugged, the reservoir has been permanently isolated for one and the remaining 13 have been fully abandoned (Table 4.25 and Figure 4.33; OGA, 2021b).

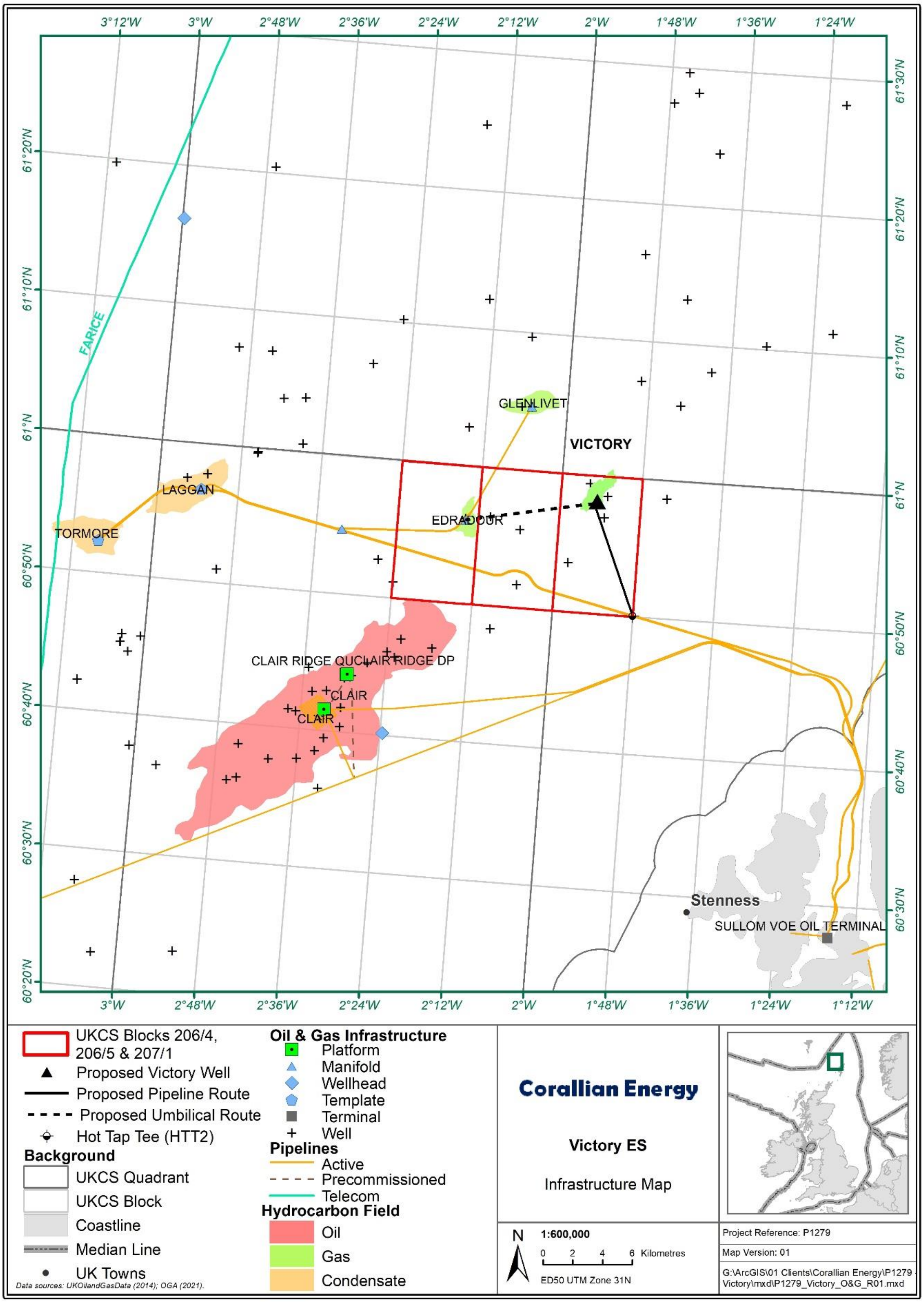
The nearest submarine cable to the proposed Victory development is the active Farice telecom cable, operated by Farice Ltd, located approximately 55 km to the north west of the proposed Victory development area at its nearest point (see Figure 4.33; KIS-ORCA, 2021).

There are no planned, consented or operational offshore wind farms within the vicinity of the proposed Victory development area and no planned natural gas or CO_2 storage projects.

Table 4.25: Well Information for wells in UKCS Blocks 207/1, 206/4 and 206/5

Operator	DECC Well Origin Wellbore Name	Well Origin Spud Date	Spud Completion Date	Original Well Intent	Current Status	Water Depth (m)	Distance to Proposed Victory Well
Total Energies E&P UK Limited	206/04a- 5Z	28/08/2019	18/11/2019	Appraisal	Abandoned	296	18 km SW
Total Energies E&P UK Limited	206/04a- 5	16/07/2019	28/08/2019	Appraisal	Abandoned	296	18 km SW
Total Energies E&P UK Limited	206/04a- 3Z	15/02/2014	27/05/2014	Exploration	Abandoned	296	18 km SW
Total Energies E&P UK Limited	207/01a- 4Z	05/09/1990	14/10/1990	Exploration	Abandoned	128	9 km SW
Total Energies E&P UK Limited	206/04a- 4	27/05/2018	17/09/2018	Exploration	Plugged	320	18 km SW
Chevron Britain Limited	207/01- 3	29/09/1977	29/10/1977	Exploration	Abandoned	157	0.5 km SW
Total Energies E&P UK Limited	206/04a- 3	02/09/2012	14/02/2014	Exploration	Abandoned	296	18 km SW
Total Energies E&P UK Limited	206/04- 2	15/08/2010	01/09/2011	Exploration	Completed (Operating)	296	18 km SW
Chevron Britain Limited	207/01- 2	04/09/1977	27/09/1977	Exploration	Abandoned	140	2 km SE
Harbour Energy	206/05- 2	18/07/1995	03/09/1995	Exploration	Abandoned	179	11 km SW
Harbour Energy	206/04- 1	25/07/1996	07/09/1996	Exploration	Abandoned	203	29 km SW
DNO North Sea (U.K.) Limited	206/05a- 3	07/07/2011	01/09/2011	Exploration	Abandoned	127	15 km SW
No Data Available	206/05- 1	22/04/1976	04/09/1976	Exploration	Abandoned	284	14 km SW
Ithaca Oil and Gas Limited	207/01a- 5	19/05/1996	12/06/1996	Appraisal	Abandoned	162	1.5 km NE
Chevron Britain Limited	207/01- 1	17/08/1977	30/08/1977	Exploration	Abandoned	185	3 km NW
Chevron Britain Limited	207/01a- 4	11/08/1990	05/09/1990	Exploration	Abandoned	128	9 km SW

Figure 4.33: Infrastructure in the Vicinity of the Proposed Victory Development



4.4.4 Dredging and Disposal Activity

There are no commercial or capital dredging activities undertaken, neither are there any sites licenced for disposal of dredged material (Crown Estates, 2021).

4.4.5 Military Activity

There are no military Practice and Exercise Areas (PEXAs) designated in the vicinity of the proposed Victory development area (Hydrographer of the Navy, 2015). However, a licence condition identified by the Ministry of Defence (MoD) exists for Blocks 207/1 and 206/5 as they lie within MoD training ranges (OGA, 2016b). The licence condition stipulates that the MoD must be consulted 12 weeks in advance of placement of any installation (fixed or floating) related to oil and gas activity within the block (OGA, 2016b).

4.4.6 Wrecks

No protected wrecks or non-designated wrecks are located in the vicinity of the proposed Victory development area and no wrecks were observed during the environmental baseline survey.

4.4.7 Tourism and Leisure

In general, tourism and leisure activities are focussed along the coastline and nearshore water of the Shetland Islands, inshore of the proposed Victory development area. Coastal tourism activities include wildlife watching for birds, otters, cetaceans and pinnipeds, as well as recreational and sport fishing activities. Scuba diving is also popular due to the extensive rocky shores and kelp beds which support a diverse assemblage of species (DTI, 2005; Visit Shetland, 2021). In general however, tourism and leisure activities are relatively small contributors to Shetland's economy, which are dominated by oil and gas activities and commercial fisheries including mariculture (DTI, 2005).

5 Assessment Methodology

5.1 Introduction

The method Corallian has used to determine if the proposed Victory field development (the Project) is likely to have any significant effects on the environment is described in this section and follows EIA good practice guidance (e.g. EC, 2017; CIEEM, 2018; SNH and HES, 2018; IEMA, 2016).

The process commences with the identification of Project activities (or aspects) that could impact environmental and socio-economic receptors, with consideration given to both planned (routine) activities and unplanned (accidental) events.

The terms “impact” and “effect” have different definitions in EIA and one drives the other. Impacts are defined as changes to the environment as a direct result of Project activities. Effects are defined as the consequences of those impacts upon receptors.

The type of impacts which could occur from the Project are categorised as follows:

- **Direct:** resulting from a direct interaction between a planned or unplanned Project activity and a receptor;
- **Indirect:** occurring as a consequence of a direct impact and may arise as a result of a complex pathway and be experienced at a later time or spatially removed from the direct impact;
- **In-combination:** arising from different activities within the Project resulting in several impacts on the same receptor or where different receptors are adversely affected to the detriment of the entire ecosystem;
- **Cumulative:** resulting from incremental changes caused by other past, present or reasonably foreseeable projects/proposals together with the Project itself.

The nature, duration, scale and frequency of these impacts can be described as adverse or positive, short-, medium- or long-term, temporary or permanent, localised or widespread, transboundary (i.e. impacting on other countries), one-off, intermittent or continuous.

Impacts that could potentially result in significant effects have been subject to detailed assessment based on best available scientific evidence and professional judgement so that, where necessary, measures can be taken to prevent, reduce or offset what might otherwise be significant adverse effects on the environment through design evolution or operational mitigation measures.

Residual effects are those that are predicted to remain assuming the successful implementation of the identified mitigation measures and are reviewed by Corallian to confirm that the Project complies with legal requirements and does not adversely impact Marine Planning policy goals and objectives (refer to Appendix A).

5.2 Identification of Environmental Impacts

In order to identify the potential environment impacts arising from the development of the Victory field (both from planned (routine) activities and unplanned (accidental) events), a preliminary scoping exercise was undertaken by Corallian and the EIA team, with reference to the requirements of the EIA Regulations and associated BEIS guidance (BEIS, 2021b).

The results of this exercise are documented in the receptor based activity and events matrix in Table 5.1. An initial high-level assessment of the aspects identified was then undertaken against the significance criteria defined in Section 5.3 to determine whether there is the potential for any of the impacts to result in significant effects on the environment.

Table 5.1: Potential Interactions and Significance of Impacts to Receptors from the proposed Victory Field Development

Assessment Topic	Aspect (Project Activities / Unplanned Events)	Physical Environment			Biological Environment						Human Environment							
		Seabed Sediments	Water Quality	Air Quality / Climate	Plankton	Seabed Communities	Fish	Seabirds	Marine Mammals	Marine Protected Areas	Commercial Shipping	Commercial Fisheries	Offshore Energy Infrastructure / Cables	Dredging & Disposal Activities	Military Activity	Cultural Heritage	Tourism & Recreation	Population & Human Health
Physical Presence	Presence of MODU and vessels during drilling, installation and commissioning activities																	
	Presence of subsea infrastructure, associated protection material and 500m exclusion zone																	
Seabed Disturbance	Anchoring of MODU																	
	Deposit of drill cuttings and cement on the seabed																	
	Installation of pipeline and umbilical																	
	Dredging of sand waves (optional) to install the pipeline																	
	Installation of wellhead, Xmas tree, and WHPS, PLEM / pigging skids and tie-in / protection Structures																	
	Installation of tie-in spools, jumpers and associated protection material																	
	Tie-in to the hot tap tee in the 18 inch Laggan - Tormore pipeline																	
	Tie-in to the Edradour manifold																	

Assessment Topic	Aspect (Project Activities / Unplanned Events)	Physical Environment			Biological Environment						Human Environment							
		Seabed Sediments	Water Quality	Air Quality / Climate	Plankton	Seabed Communities	Fish	Seabirds	Marine Mammals	Marine Protected Areas	Commercial Shipping	Commercial Fisheries	Offshore Energy Infrastructure / Cables	Dredging & Disposal Activities	Military Activity	Cultural Heritage	Tourism & Recreation	Population & Human Health
Underwater Noise Emissions	Use of propellers / DP thrusters on vessels																	
	Drilling operations (e.g. rotating machinery)																	
	Piling operations to install WHPS, PLEM / Pigging Skid and Tie-in / Protection Structures																	
Atmospheric Emissions	Power generation on MODU, vessels and helicopters during drilling, installation and commissioning activities																	
	Flaring of hydrocarbons during well flow test																	
Marine Discharges	Discharge of drill cuttings and muds during drilling operations																	
	Discharge of residual hydrocarbons when drilling through the payzone																	
	Discharge of completion bring during well clean-up activities																	
	Routine discharges to sea (domestic sewage, food waste etc.) from MODU and vessels during drilling, installation and commissioning activities																	
	Discharge of ballast water (potential for introduction of alien species) from MODU and vessels																	

Assessment Topic	Aspect (Project Activities / Unplanned Events)	Physical Environment			Biological Environment						Human Environment							
		Seabed Sediments	Water Quality	Air Quality / Climate	Plankton	Seabed Communities	Fish	Seabirds	Marine Mammals	Marine Protected Areas	Commercial Shipping	Commercial Fisheries	Offshore Energy Infrastructure / Cables	Dredging & Disposal Activities	Military Activity	Cultural Heritage	Tourism & Recreation	Population & Human Health
	Discharge of chemicals during drilling, installation and commissioning activities																	
	Release of hydraulic fluid during subsea valve operation and maintenance																	
Solid Waste	Onshore disposal of solid waste generated during drilling, installation and commissioning activities																	
Accidental Events	Well blowout (releasing large quantities of condensate and gas) in the event of a loss of well control																	
	MODU or vessel collision (loss of diesel inventory)																	
	Pipeline rupture and subsequent release of hydrocarbons to sea																	
	Subsea control system failure resulting in a minor release of hydraulic / control fluid to sea																	
	Minor release of hydrocarbons / chemicals to sea (e.g. from drains, bunkering operations etc.) during drilling, installation and commissioning activities																	
	Snagging of Victory subsea infrastructure																	

Assessment Topic	Aspect (Project Activities / Unplanned Events)	Physical Environment			Biological Environment						Human Environment							
		Seabed Sediments	Water Quality	Air Quality / Climate	Plankton	Seabed Communities	Fish	Seabirds	Marine Mammals	Marine Protected Areas	Commercial Shipping	Commercial Fisheries	Offshore Energy Infrastructure / Cables	Dredging & Disposal Activities	Military Activity	Cultural Heritage	Tourism & Recreation	Population & Human Health
	Dropped objects resulting in unplanned disturbance to seabed																	

Key

	Potentially significant impacts (aspects scoped in for further assessment)		No potential for significant effects (aspects scoped out from assessment)		No interaction

5.2.1 Aspects Subject to Further Assessment

Based on the characteristics of the project as described in Section 3 and the environmental sensitivities identified in Section 2, Corallian has determined that the aspects summarised in Table 5.2 could potentially result in significant environmental effects. A comprehensive assessment has therefore been undertaken for these aspects, using the significance criteria defined in Section 5.3, the results of which are documented in Sections 5 to 11 of the ES.

Table 5.2: Aspects Subject to Further Assessment

Assessment Topic	Aspect	Receptors	ES Section
Physical Presence	Presence of MODU and vessels during drilling, installation and commissioning activities Presence of subsea infrastructure, associated protection material and 500m exclusion zone	Commercial Shipping, Commercial Fisheries	Section 6
Seabed Disturbance	Anchoring of MODU Deposit of drill cuttings and cement on the seabed Installation of pipeline and umbilical (rock carpet option) Removal of boulders from pre-lay corridors (seabed lay option) Dredging of sand waves (optional) to install the pipeline Installation of wellhead, Xmas tree, and WHPS, PLEM / pigging skids and tie-in / protection structures Installation of tie-in spools, jumpers and associated protection material Tie-in to the hot tap tee in the 18 inch Laggan - Tormore pipeline, including removal of existing protection (rock berm) Tie-in to the Edradour manifold, including removal of existing protection (rock berm) and GRP	Seabed Sediments, Seabed Communities, Fish	Section 7
Underwater Noise Emissions	Use of propellers / DP thrusters on vessels Drilling operations (e.g. rotating machinery) Piling operations to install WHPS, PLEM / Pigging Skid and Tie-in / Protection Structures	Fish	Section 8
Atmospheric Emissions	Power generation on MODU, vessels and helicopters during drilling, installation and commissioning activities Flaring of hydrocarbons during the well flow test	Air Quality, Climate	Section 9
Marine Discharges	Discharge of drill cuttings and muds Discharge of chemicals during drilling, installation and commissioning activities Discharge of residual hydrocarbons when drilling through the payzone Discharge of completion brine during well clean-up activities	Water Quality, Plankton, Fish	Section 10
Accidental Events	Well blowout (releasing large quantities of condensate and gas) in the event of a loss of well control MODU or vessel collision (loss of diesel inventory) Pipeline rupture and subsequent release of hydrocarbons to sea	Seabed Sediments, Water Quality, Plankton, Seabed Communities, Fish, Seabirds, Marine Mammals, Marine Protected Areas, Commercial Fisheries,	Section 11

Assessment Topic	Aspect	Receptors	ES Section
		Tourism & Recreation, Population & Human Health	

5.2.2 Aspects Scoped out of Further Assessment

A number of aspects were not considered to result in significant environmental effects and were therefore scoped out from further assessment. A justification for this is provided in Table 5.3.

Table 5.3: Aspects Scoped out of Further Assessment

Topic	Aspect (Project Activities / Unplanned Events)	Justification / Control Measures
Marine Discharges	Routine discharges to sea (domestic sewage, food waste etc.) from MODU and vessels during drilling, installation and commissioning activities	Food waste will be macerated to increase the rate of dispersion and biodegradation at sea and waste water will be treated before being discharged to sea, in accordance with the requirements of the MARPOL convention.
	Discharge of ballast water (potential for introduction of alien species) from MODU and vessels	Only vessels adhering to the IMO 2011 Guidelines for the Control and Management of Ships' Biofouling to Minimize the Transfer of Invasive Species will be used.
	Release of hydraulic fluid during subsea valve operation and maintenance	Hydraulic fluid selection for the Victory field development will be aligned with the existing Edradour subsea infrastructure.
Solid Waste	Onshore disposal of solid waste generated during drilling, installation and commissioning activities	Waste will be dealt with in accordance with regulatory requirements. The principles of the Waste Management Hierarchy will be followed, licensed waste contractors will be used and Waste Management Duty of Care audits will be carried out. Vessels will conform to their own Waste Management Plans.
Accidental Events	Subsea control system failure resulting in a minor release of hydraulic / control fluid to sea	Any impacts on water quality and marine fauna will be localised and temporary. Integrity management procedures will be in place to minimise the risk of failure.
	Minor release of hydrocarbons / chemicals to sea (e.g. from drains, bunkering operations etc.) during drilling, installation and commissioning activities	Any impacts on water quality and marine fauna will be localised and temporary. Standard operating procedures will be adhered to, e.g. bunkering in good light, regular hose inspection, correct storage and segregation of chemicals etc.
	Snagging of Victory subsea infrastructure	A 500 m exclusion zone will be applied for around the Victory WHPS and Victory PLEM / Pigging Skid. The pipeline and umbilical will be rock dumped post lay. Tie-in and protection structures will be overtrawlable. Subsea infrastructure will be marked on navigation charts.
	Dropped objects resulting in unplanned disturbance to seabed	Dropped object procedures are industry-standard and will be employed throughout the proposed operations.

5.3 Significance Evaluation

5.3.1 Planned Events

For planned activities, the significance of environmental effects has been evaluated by considering the sensitivity of the receptor affected in combination with the magnitude of impact that is likely to arise. Where it is not possible to quantify impacts, qualitative assessments have been carried out, based on available knowledge and professional judgement.

Sensitivity Criteria

Sensitivity is a function of the value of the receptor (a measure of its importance, rarity and worth), its capacity to accommodate change when a pressure is applied (resistance or tolerance), and its subsequent recoverability (resilience). The criteria presented in Table 5.4 has been used as a guide to determine the sensitivity of receptors.

Table 5.4: Determining Sensitivity

		Resistance and Resilience			
		Very High	*High*	*Medium*	*Low*
Value	*Low*	Low	Low	Medium	Medium
	Medium	Low	Medium	Medium	High
	High	Low	Medium	High	Very High
	Very High	Medium	High	Very High	Very High

Definitions:

Resistance and Resilience	
Very High:	Highly adaptive and resilient to pressure. High recoverability in the short-term.
High:	Some tolerance / capacity to accommodate pressure. High recoverability in the medium-term.
Medium:	Limited tolerance / capacity to accommodate pressure. Recoverability is slow and/or costly.
Low:	Very limited or no tolerance / capacity to accommodate pressure. Recovery is unlikely or not possible.
Value	
Very High:	Very high value and/or of international importance.
High:	High value and/or of national importance.
Medium:	Moderate value and/or of regional importance.
Low:	Low value and/or of local importance.

Magnitude of Impact Criteria

The magnitude of impact considers the characteristics of the change that is likely to arise (a function of the spatial extent, duration, reversibility and likelihood of occurrence of the impact) and can be adverse or positive. The criteria presented in Table 5.5 has been used as a guide to define the magnitude of impact.

Table 5.5: Determining Magnitude of Impact

Magnitude	Definition
Substantial	Permanent or long-term (>5 years) change in baseline environmental conditions, which is certain to occur. Impact may be one-off, intermittent or continuous and/or experienced over a very wide area (i.e. international and/or transboundary in nature). Impact is likely to result in environmental quality standards or threshold criteria being routinely exceeded.
Major	Medium to long-term (1 – 5 years), reversible change in baseline environmental conditions, which is likely to occur. Impact may be one-off, intermittent or continuous and/or experienced over a wide area (i.e. national in scale). Impact could result in one-off exceedance of environmental quality standards or threshold criteria.
Moderate	Short to medium-term (< 1 year), temporary change in baseline environmental conditions, which is likely to occur. Impact may be one-off, intermittent or continuous and/or regional in scale (i.e. beyond the area surrounding the Project site to the wider region). Impact is unlikely to result in exceedance of environmental quality standards or threshold criteria.
Minor	Short-term (< 1 week), temporary change in baseline environmental conditions, which could possibly occur. Impact may be one-off, intermittent and/or localised in scale, limited to the area surrounding the proposed Project site. Impact would not result in exceedance of environmental quality standards or threshold criteria.
Negligible	Immeasurable or undetectable changes (i.e. within the range of normal natural variation).

Significance of Effects

The overall significance of an effect has been determined by cross referencing the sensitivity of the receptor with the magnitude of impact, using the matrix shown in Table 5.6.

Table 5.6: Significance Evaluation Matrix (Planned Activities)

		Magnitude of Impact				
		Negligible	**Minor**	**Moderate**	**Major**	**Substantial**
Receptor Sensitivity	**Low**	Negligible	Minor	Minor	Minor	Minor / Moderate[1]
	Medium	Negligible	Minor	Minor	Moderate	Moderate / Major[1]
	High	Negligible	Minor	Moderate	Major	Major
	Very High	Negligible	Minor / Moderate[1]	Moderate / Major[1]	Major	Major

[1] The choice of significance level is based upon professional judgement and has been justified in the assessment text.

In the context of this assessment, effects classed as **Major** or **Moderate** are considered to be 'significant' in EIA terms and therefore mitigation measures are required to be identified in order to prevent, reduce or offset adverse significant effects or enhance positive effects. The overall significance of the effect is then re-evaluated, taking the mitigation measures into consideration, to determine the residual effect utilising the methodology outlined above.

Effects classed as **Minor** are not considered to be significant and are usually controlled through good industry practice.

Effects classed as **Negligible** are also not considered to be significant.

5.3.2 Unplanned Events

For unplanned events, such as accidental hydrocarbon releases, significance has been determined using a risk assessment approach, where the likelihood (probability) of the unplanned event occurring is considered against the consequence (significance of effect) if the event was to occur.

The consequence (significance of effect) has been determined using the methodology for planned events as described in Section 5.3.1 above. The likelihood of an unplanned event occurring has been determined using the criteria presented in Table 5.7 as a guide.

Table 5.7: Determining Likelihood of Occurrence

Likelihood	Definition
Extremely Rare	Event is extremely unlikely to occur during the Project, given good industry practice. Frequency of event: 1×10^{-4}.
Rare	Event is very unlikely to occur during the Project, given good industry practice. Frequency of event: 1×10^{-3}.
Unlikely	Event is unlikely to occur during the Project, given good industry practice. Frequency of event: 1×10^{-2}.
Possible	Event could occur during the Project, based on industry data. Frequency of event: 1×10^{-1}.
Likely	Event is likely to occur at least once during the Project. Frequency of event: > 1

A risk category (low, medium or high) has then been assigned to the unplanned event using the matrix shown in Table 5.8.

In the context of this assessment, **High** risk events are considered to be "significant" in EIA terms and are unacceptable.

Medium risk events are also considered to be "significant" in EIA terms, unless it can be demonstrated that the risk has been reduced to as low as reasonably practicable (ALARP) through mitigation measures and good industry practice.

Low risk events are not considered to be "significant" in EIA terms, but should still be controlled through good industry practice.

Table 5.8: Significance Evaluation Matrix (Unplanned Events)

		Consequence (Significance of Effect) [1]			
		Negligible	Minor	Moderate	Major
Likelihood of Event	Extremely Rare	LOW	LOW	MEDIUM	MEDIUM
	Rare	LOW	LOW	MEDIUM	MEDIUM
	Unlikely	LOW	LOW	MEDIUM	HIGH
	Possible	LOW	MEDIUM	MEDIUM	HIGH
	Likely	LOW	MEDIUM	HIGH	HIGH

[1] The consequence (significance of effect) has been determined using the methodology for planned events as described in Section 5.3.1 above.

6 Physical Presence

6.1 Introduction

This section assesses the potentially significant impacts on other sea users, namely commercial shipping and commercial fisheries, which could arise from:

- The presence of the mobile offshore drilling unit (MODU) and vessels during drilling operations, subsea infrastructure installation and hook-up and commissioning activities;
- The presence of subsea infrastructure, associated protection material and 500m exclusion zone surrounding the Victory well location.

6.2 Assessment of Impacts

6.2.1 Commercial Shipping

The proposed drilling phase will involve the use of a semi-submersible drilling rig, which will be on location at Victory for a period of up to 52 days. A number of support vessels will also be on location or transiting to / from the Victory location during this period, including tugs, AHV, ERRV and supply vessels (see Section 3.3.3). Drilling operations are currently scheduled to be undertaken in Q2 2024. While the MODU is on location, a 500 m safety exclusion zone will be in place, which will be patrolled by the ERRV. As such, an area of 0.8 km^2 at the sea surface will be unavailable to commercial shipping. Although the 500 m safety zone around the MODU will be temporary, Corallian will apply for a 500 m exclusion zone to be in place around the Victory well from the point when the MODU moves off location. Commercial shipping will therefore have to avoid this area for the life of the Victory field development.

Given the above, shipping vessels may have to re-route around the Victory location. This could lead to extended passage times and have knock-on effects on the users of other nearby shipping routes in the area. Shipping activity is considered to be low to moderate in the area, with the average density of vessels transiting through the area ranging from 5 transits or less to 5-50 transits per week, predominantly comprised of vessels serving existing West of Shetland oil and gas installations (see Section 4.4.2). Notwithstanding this, a full collision risk assessment will be undertaken by Corallian to inform the Consent to Locate (CTL) permit applications, required to site the MODU and subsea infrastructure at the Victory location.

In addition, during the subsea infrastructure installation and hook-up commissioning phase, a number of DP vessels will be on location for a period of months from May to October 2024. The vessels required include, pipelay reel-lay vessel, umbilical lay vessel, rock dump vessel, DSV / MSV and survey and utility vessels (see Section 3.4.7). The main navigational hazard will be associated with the installation of the pipeline and umbilical as activity at Victory and Edradour will be within 500 m safety zones. Corallian therefore proposes to utilise up to three guard vessels to patrol the length of the pipeline and umbilical whilst installation activities are ongoing. The vessels involved in subsea infrastructure installation operations will also update their marks, lights and navigational status broadcast on AIS to indicate to other vessels when they are restricted in manoeuvrability. No shipping lanes will be impacted in the event that the lay corridors are pre-cleared, requiring residual boulders greater than 0.5 m to be moved to a disposal corridor located approximately 3 m away from the edge of the cleared corridor (see Section 3.4.4).

The sensitivity of shipping to displacement as result of the Victory development is therefore considered to be **Low**. The receptor is of regional importance, classed as Medium value, but resistance and resilience is Very High as there is adequate sea room for shipping to re-route or avoid the Victory location, as necessary, particularly as the density of traffic transiting through the area is not high. The magnitude of impact is predicted to be **Minor** as any impact will be localised to the Victory location. Effects on shipping from the physical presence of the MODU and vessels during drilling, subsea infrastructure installation and hook-up commissioning activities, as well as the long term presence of the Victory 500 m safety exclusion zone, are therefore assessed as **Minor** and not significant. Mitigation measures are proposed in Section 6.3 to ensure that good industry practice is followed.

6.2.2 Commercial Fishing

The physical presence of the Victory seabed infrastructure, as well as the temporary presence of the MODU mooring system, will pose a potential snagging hazard to fishing gears towed along the seabed. The area in the vicinity of the proposed Victory development is known to be heavily fished, by both Scottish and international vessels, with effort dominated by trawlers.

VMS data indicates that Victory is located within an area of high demersal fishing effort, targeting species including saithe, monkfish, cod, ling and haddock (see Section 4.4.1). Throughout the year, catches are relatively high within ICES Rectangles 50E7 and 50E8, but are consistently greater in the spring months in ICES Rectangle 50E7 (along the umbilical route to the Edradour manifold) and the winter months in ICES Rectangle 50E8 (at the Victory well location and along the pipeline route to HTT2). The Victory development operations will therefore avoid these periods, with the proposed drilling operations currently scheduled to be undertaken in Q2 2024 and the subsea infrastructure installation and hook-up commissioning activities scheduled to occur between May and October 2024. There is likely to be some overlap between the activities, with the proposed drilling operations likely to take place at the same time as the hot tap tee work, followed by installation of the Victory pipeline and umbilical. Multiple vessels are therefore likely to be working at the Victory location simultaneously.

During the proposed drilling operations, the MODU will be moored in position via an eight-point mooring system, comprised of a combination of chain and wire, with the length of each mooring line estimated to be approximately 1,100 m in length. It is assumed that all eight anchors of the MODU will extend outside of the temporary 500 m safety exclusion zone. As a result, fishing vessels, particularly benthic trawlers and those with pelagic mobile gear, are likely to be displaced from a larger area, in the region of 3.8 km^2. This is a conservative figure as it assumes loss of access to a radius equal to the length of the anchors around the MODU, which is unlikely to be the case. For example, pelagic fishing vessels are more capable of operating close to the mooring system, as their fishing gear is suspended in the water column. An ERRV will be used during this period to deter vessels from the area, thereby preventing potential interaction with the mooring lines beyond the 500m exclusion zone. In addition, information on the location of the drilling rig and associated anchor pattern and temporary 500 m safety zone will also be communicated to other sea users (via the United Kingdom Hydrographic Office) through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings.

Once the MODU moves off location, fishing will be displaced from a smaller area throughout the life of the field development, which corresponds to the 500 m statutory exclusion zone that Corallian intends to apply for around the Victory well (equivalent to an area of 0.8 km^2). In addition, to further reduce the risk of snagging, the wellhead and Xmas tree will be protected by an industry standard fishing friendly WHPS. Note, the formation of anchor mounds is unlikely for this development, given the sandy nature of the sediments at the Victory location (see Section 4.2.2).

In addition to the above, during installation of the pipeline and umbilical, fishing vessels will be temporarily displaced from the working corridors, with the area remaining unavailable to commercial fisheries until rock has been placed over the lines for protection and upheaval buckling mitigation. The profile of the rock berms once deposited will be overtrawlable. Based on a working corridor width of 20 m for the pipeline (16.2 km in length) and 10 m for the umbilical (18 km in length), it is estimated that vessels will be displaced from an area of approximately 0.5 km^2. An additional area may be impacted in the event that the lay corridors are pre-cleared. In this instance, residual boulders greater than 0.5 m will be moved to a disposal corridor located approximately 3 m away from the edge of the cleared corridor and their as-left position recorded (see Section 3.4.4). As noted above, to minimise the risk to fishing vessels, Corallian proposes to use up to three guard vessels to patrol the length of the pipeline and umbilical whilst installation activities are ongoing, with each guard vessel patrolling a length of line of up to approximately 10 km. This approach has been discussed with SFF and Corallian will continue to consult with SFF during the detailed design phase and planning process for the subsea infrastructure installation activities.

To ensure the integrity of the Victory infrastructure at the seabed and prevent damage in the event of contact with fishing gears, the Victory PLEM / pigging skid and tie-in / protection structures will all be designed to be overtrawlable. Concrete mattresses will be placed over the tie-in spools and control jumpers located within the 500 m safety zones at Victory and Edradour and a combination of rock and concrete mattresses will be used to protect the flexible flowline and crossing points between HTT2 and the Victory tie-in structure (see Section 3.4.5).

In summary, fishing vessels will need to avoid the Victory development area whilst the proposed subsea infrastructure installation operations are ongoing, assumed to be from May to October 2024. There will therefore be a temporary loss of fishing grounds which could result in an economic impact on the local fisheries that normally operate in the area.

Given the above, the sensitivity of commercial fishing to displacement is considered to be **Medium.** The area of the Victory field is heavily fished; the receptor therefore has a Very High value, but there is adequate sea room in the wider West of Shetland area for fishing vessels to switch to alternative fishing grounds, hence resistance and resilience is Very High. The magnitude of impact is predicted to be **Minor** as any impact will be localised to the Victory location. The rock berms over the length of the pipeline and umbilical and the PLEM / pigging skid, tie-in and protection structures will all be overtrawable. In the long term, fishing vessels will only be prevented from entering an area of 0.8 km^2 at the Victory well location. Effects on commercial fishing from physical presence are therefore **Minor** and not significant. Mitigation measures are proposed in Section 6.3 to ensure that good industry practice is followed.

6.3 Mitigation Measures

Impacts from the physical presence of the MODU and vessels during drilling, subsea infrastructure installation and hook-up and commissioning activities, as well as the long term presence of the Victory subsea infrastructure, associated protection material and 500 m safety exclusion zone, will be minimised by the implementation of the following mitigation measures:

- 500 m safety exclusion zone will be designated around the MODU and a dedicated ERRV will be present during the drilling operations to monitor movements of other vessels in the area and prevent them entering the exclusion zone.
- A full collision risk assessment will be undertaken by Corallian to inform the CTL permit applications, required to site the MODU and subsea infrastructure at the Victory location.
- Information on the location of the drilling rig and associated anchor pattern, 500 m safety zone, subsea infrastructure and vessel operations, including those involved in pipelay activities, will be communicated to other sea users (via the United Kingdom Hydrographic Office) through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings.
- Corallian will continue to consult with SFF during the detailed design phase and planning process for the subsea infrastructure installation activities and an onshore Fisheries Liaison Officer (FLO) will be appointed to maintain good communication with local fisheries and co-ordinate activities, particularly when installation the pipeline and umbilical.
- Vessel use will be optimised by minimising the number of vessels required and length of time vessels are on site. This will be managed via a vessel management plan.
- Vessels involved in subsea infrastructure installation operations will update their marks, lights and navigational status broadcast on AIS to indicate when they are restricted in manoeuvrability. This will assist any passing vessels that encounter the installation vessels.
- Up to three guard vessels (each patrolling a stretch of up to approximately 10 km in length) will be present on site during the pipeline and umbilical installation activities, prior to the deposit of protection (rock) on top of the lines, to ensure that other sea users are aware of the ongoing operations.
- Pipeline working corridors will be minimised, as far as possible.
- Subsea infrastructure and the Victory 500 m safety zone will be marked as hazards on admiralty charts and entered into the FishSafe system so they can be avoided by fishing vessels.

- Maintenance inspection surveys will be undertaken throughout the life of the Victory field to ensure the seabed infrastructure and associated protection material remain in a favourable condition.

6.4 Residual Effects

In summary, no significant residual effects on other sea users are predicted as a result of the physical presence of the MODU and vessels during drilling, subsea infrastructure installation and hook-up and commissioning activities, as well as the long term presence of the Victory subsea infrastructure, associated protection material and 500 m safety exclusion zone. There is adequate sea room for shipping to re-route or avoid the Victory location, as necessary, particularly given the low density of vessel traffic in the area. Fishing vessels will be temporarily displaced from the Victory development area for a period of up to five months (May to October 2024) during the drilling and subsea infrastructure installation phases, with an area of 0.8 km^2 surrounding the Victory well lost for the life of the field development. This is considered to be a very small area in comparison to the alternative fishing grounds available in the wider West of Shetland area.

6.5 Transboundary Impacts

The Victory field is located approximately 110 km to the south east of the UK/Faroe median line; however, foreign vessels are known to actively fish in the area. In advance of the proposed offshore development activities commencing, Corallian will ensure that international fishing organisations, with known vessels working within the area of the Victory field, are informed of the proposed works via appropriate fishing notifications. Significant transboundary impacts are therefore not predicted.

6.6 Cumulative Impacts

Corallian is aware that Equinor's proposed West of Shetland Rosebank field development is scheduled for a key financial investment decision in 2022. If a decision is made to proceed with the development there is a possibility that field development activities for Rosebank could be ongoing at the same time as Victory. Rosebank is located approximately 130 km north west of the Shetland Islands and is in much deeper water than Victory at approximately 1,100 m. The gas pipeline will run in a south-east direction from the Rosebank field for approximately 236 kilometres, before tying into the SIRGE pipeline in the central North Sea. This route lies to the south of BP's Claire field and is therefore some distance from the proposed Victory field. Given the mitigation measures which will be in place for Victory, significant cumulative impacts on other sea users are therefore not predicted.

Long term loss of access is restricted to an area totalling 0.8 km^2 at the Victory well location for the life of the field development. This is very small in comparison to the fishing grounds available in the wider West of Shetland area. In addition, as the Victory PLEM / pigging skid and tie-in / protection structures will all be designed to be overtrawlable and the rock berm covering the pipeline and umbilical will be overtrawlable, a significant cumulative increase in snagging risk with other oil and gas development in the area is not anticipated.

7 Seabed Disturbance

7.1 Introduction

This section discusses the potentially significant environmental impacts on seabed sediments, seabed communities and fish arising from:

- Anchoring of the MODU;
- Deposit of drill cuttings and cement on the seabed;
- Installation of the pipeline and umbilical (rock carpet option);
- Removal of boulders from pre-lay corridors (seabed lay option);
- Dredging of sand waves (optional) to install the initial 2.5 km section of the pipeline from the Victory well;
- Installation of the wellhead, Xmas tree and WHPS, PLEM / pigging skids and tie-in / protection structures;
- Installation of the tie-in spools, jumpers and associated protection material;
- Tie-in to the hot tap tee in one of the 18 inch Laggan Tormore pipelines (HTT1-2 on FL1), including removal of existing protection (rock berm);
- Tie-in to the Edradour manifold, including removal of existing protection (rock berm).

7.2 Quantification of Impact Area

7.2.1 Anchoring of the MODU

The well will be drilled from a semi-submersible drilling rig, which will be moored on location at Victory using anchors. It is assumed that the MODU will have a total of 8 mooring lines, each up to 1,100m in length.

The dimensions of each anchor are assumed to be approximately 6 m by 6 m, therefore, the deployment of eight anchors will disturb an area of seabed equal to 288 m^2 (0.0003 km^2). In addition, the maximum length of mooring line to touch down on the seabed for all eight anchors is 6,600 m (based on three quarters of the length of each mooring line (i.e. 825 m) being laid on the seabed). It has been assumed that a 10 m wide corridor of seabed will be disturbed per mooring chain. This is a worst case estimate and allows for the lateral movement of the mooring lines on the seabed during installation and retrieval. Therefore, the deployment of eight mooring lines will disturb an area of seabed equal to 66,000 m^2 (0.066 km^2).

The total seabed disturbance area from MODU anchor and mooring lines is equal to circa. 66,288 m2 (0.07 km^2).

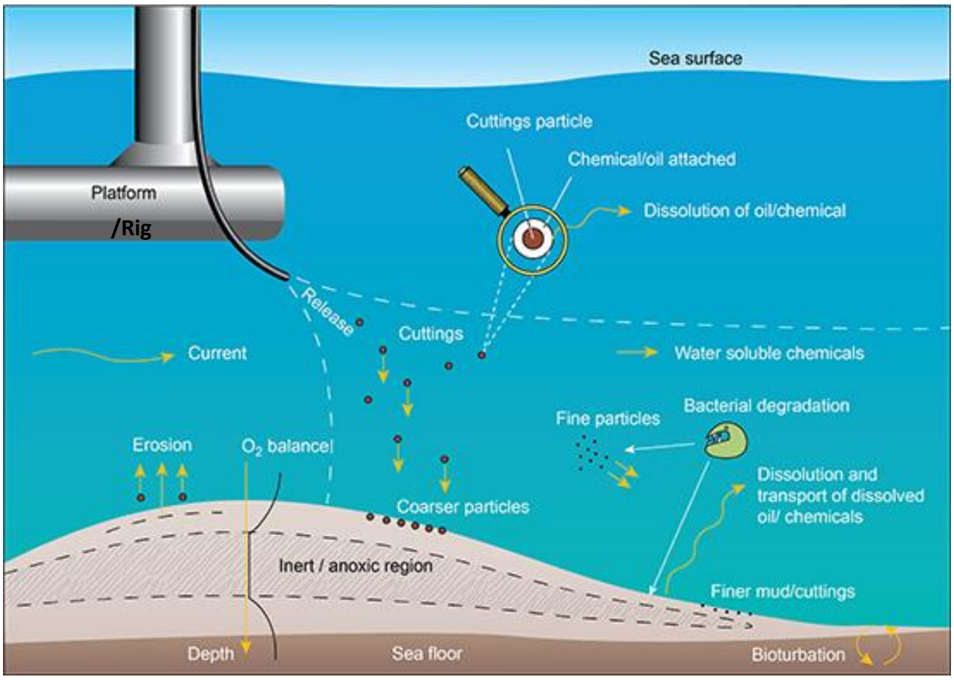
7.2.2 Deposit of Drill Cuttings and Cement

As described in Section 3.3.5, the top two Victory well sections (36" and 17½") will be drilled riserless, with seawater and frequent bentonite “sweeps” passed down the well to clean out the hole. Cuttings from these top-hole sections (353 tonnes) be discharged directly from the wellbore at the seabed and will form a pile in the immediate vicinity of the Victory drill centre location.

The deeper well sections (12¼" and 8½") will be drilled with a KCl glycol polymer WBM. The drilling fluids and cuttings (159 tonnes) from these sections will be returned to the rig and will be separated. The recovered WBM will be recycled downhole by the mud pump in a closed loop system. The cuttings will be passed through a cleaning system and discharged to sea from the drilling rig just below the sea surface.

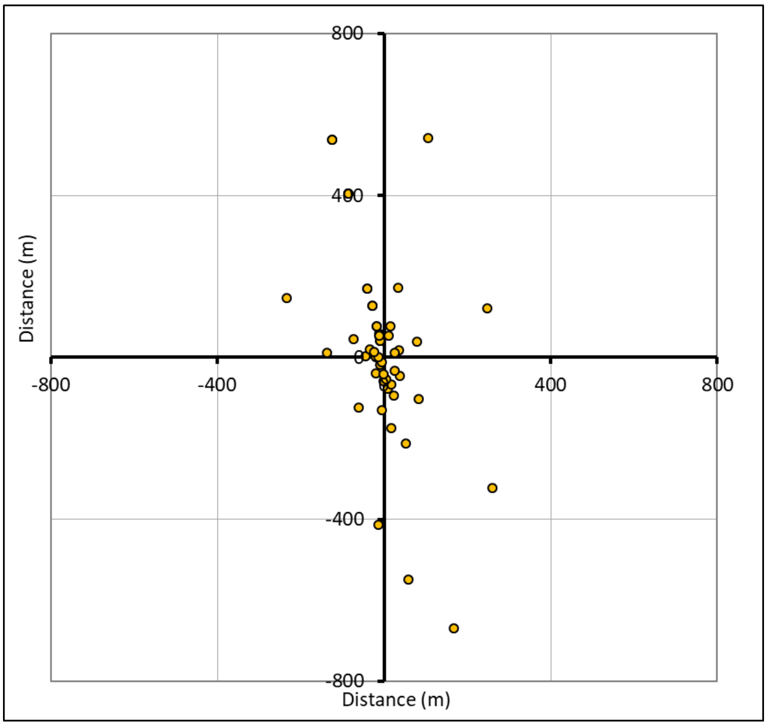
These cuttings will therefore sink from the surface to the seabed (Figure 7.1) and be deposited in a pattern that reflects the nature of the cuttings (particle size distribution), the water depth, and the water movements at the time of discharge.

Figure 7.1: Fate of Drill Muds and Cuttings Discharged to Sea (SINTEF, 2014)



For the cuttings discharged from the drilling rig, a simple analytical model has been used to estimate the extent of deposition of cuttings on the seabed. The results are illustrated in Figure 7.2. The model takes into account the particle size distribution and dispersion of cuttings by currents based on data given in Fugro-GEOS, 2001 (refer to Appendix C). It does not account for re-suspension or dispersion after initial deposition on the seabed.

Figure 7.2: Predicted Cuttings Deposition (discharged 10 m below surface) on the seabed around the MODU (Axes Display x-y Distance from MODU (located at Victory))



The model calculates that the majority of WBM cuttings from the deeper well sections (ca. >85%) will be distributed within an area ca. 218 m by 85 m from the release location, aligned with the direction of the current. The maximum likely deposit thickness of the pile which would be formed from these cuttings is 3.5 mm. The remainder of the WBM cuttings particles will travel up to around 690 m from the release location, but are likely to be so widely spread that they are unlikely to be detectable against background sediments.

Cuttings dispersion modelling has previously been undertaken for the Glenlivet exploration well, drilled in 2010, located approximately 16 km north west of the proposed Victory well. It is acknowledged that the water depth at Glenlivet is deeper than Victory (435 m versus 169 m), which is likely to result in the cuttings being dispersed over a wider area. The predominant residual surface flow in the area is also towards the north-east along the contours of the continental shelf edge. The modelling assumed seawater/spud mud sweeps would be used for the top two hole sections, with WBM for the deeper sections, as is the case for the Victory well. The Glenlivet exploration well is a deeper well than Victory, therefore the cuttings dispersion modelling was performed for a total of 3,160 tonnes of mud and cuttings (compared to Victory where only 512 tonnes of cuttings will be discharged). The Glenlivet modelling is therefore considered to represent a conservative indication of the potential area of seabed which could be impacted by cuttings discharged from the Victory well.

The Glenlivet modelling predicted cuttings deposition in a 560 m by 120 m (0.85 km^2) oval-shaped area aligned in a south-west to north-east direction. The highest concentrations of cuttings (203 mm deposition thickness) were present at the discharge point; however, the thickness of cuttings deposited on the seabed was predicted to fall quickly to 5 mm within approximately 50 m of the well location and then to 1 mm or less over the remainder of the 0.85 km^2 oval area. The majority of the mud remained suspended in the water column and did not settle (Total, 2014).

To ensure a worst case is assessed, it is therefore assumed that the cuttings discharged from the Victory well be deposited within an area up to 0.85 km^2, based on the results of the Glenlivet modelling.

Note, when drilling through the reservoir interval, it is anticipated that the drill cuttings may contain residues of reservoir hydrocarbons; this would be bound in the rock removed from the well by the drilling fluid (WBM). As a worst case estimate, the 8.5 inch inclined section of the well will generate approximately 11 tonnes of cuttings, which could be contaminated with a maximum of 100 kg (0.1 tonnes) of hydrocarbons (refer to Table 3.4 in Section 3.3.5). These cuttings would be deposited within the area quantified above.

In addition, following the completion of each well section, the steel casings will be cemented in place to form a seal between the casing and formation (refer to Section 3.3.5). Most cement will remain in the annulus between the casing and the rock formation but some will be discharged at the seabed when cementing the 30 inch conductor. A ROV and chemical dye will be used to monitor cement returns during this phase to help ensure the volume of cement discharged to the seabed is kept at a minimum. Cement may also reach the seabed when cementing the 13 3/8" casing, but there are relatively small cement volumes in this section and accurately calculated estimates for excess cement will be made. In addition, some cement and chemicals may be discharged as the cementing unit is cleaned between sections. In total, approximately 12 m^3 of cement may be discharged during the proposed drilling operations, which would be deposited within the area quantified above for the cuttings pile. A cement patio is not expected to be created around the well head.

7.2.3 Installation of the Pipeline and Umbilical

Two options are currently under consideration for installation of the Victory pipeline and umbilical, subject to detailed engineering studies (refer to Section 3.4.4):

- Base case (seabed lay) option: Very narrow pre-cleared corridors will be created (one for the pipeline and one for the umbilical corridors) from which any residual boulders greater than 0.5 m will be removed. The pipeline and umbilical will be laid on the seabed within these corridors, following which they would be covered with rock to achieve stability and protection.
- Worst case (rock carpet) option: Rock protection will be used both underneath and on top of the pipeline and umbilical. A rock dump vessel would be used to install a rock carpet on the seabed, upon which the lines would be placed using a pipelay vessel. Following pipelay, further

rock would be placed on top of the pipeline and umbilical for protection and stabilisation purposes. This option is considered to be worst case from an environmental impact perspective due to the larger seabed footprint, greater quantity of rock protection material required and higher installation vessel requirements.

In the worst case (rock carpet) scenario, a total of 543,854 tonnes of rock may need to be deposited on the seabed. The total area of seabed impacted is estimated to be around 322,200 m^2 (0.3 km^2), which assumes a base rock berm width of 11 m for the pipeline and 8 m for the umbilical (refer to Table 3.7 in Section 3.4.4). This excludes seabed disturbance relating to the boulder disposal corridor.

In the event the seabed lay (base case) option is feasible, any large boulders will first be identified and removed from the pipeline and umbilical lay corridors with the use of a boulder grabber. It is assumed that the boulder disposal corridor will be approximately 5 m wide and located approximately 3 m away from the edge of the cleared corridor. Based on the environmental survey data collected to date, it is estimated that 3 boulders may need to be cleared from the pipeline corridor and 18 boulders may need to be cleared from the umbilical corridor. Assuming that each boulder will disturb an area of ca. 1 m^2 when relocated, the area of seabed disturbed within the boulder disposal corridor will be in the region of 21 m^2.

For both installation options, the initiation of the pipeline and umbilical will require the installation of a temporary initiation anchor (either a conventional anchor or dead man anchor, with dimensions of 6m by 6m) and the use of an initiation wire, which will connect between the anchor and the end of the pipeline / umbilical. During positioning it is assumed that the anchor will impact an area of 36 m^2. The initiation wire for both the pipeline and umbilical is expected to be no longer than 500 m in length. To allow for the lateral movement of the wire on the seabed during installation and retrieval, a 10 m wide disturbance corridor has been assumed, with ca. 5,000 m^2 of seabed impacted. In total, therefore, deployment and retrieval of the initiation anchor and wire will disturb an area of approximately 5,036 m^2. Following the installation of the pipeline/umbilical the anchor and wire will be recovered.

7.2.4 Dredging of Sand Waves (Optional) to install the Pipeline

Prior to the installation of the production pipeline, there may also be a requirement to dredge the top of the sand wave crests along the initial 2.5 km section of the route from the Victory well location to provide a stable base for the pipeline (refer to Section 3.4.4). The environmental survey data shows the mega ripples to have an amplitude (trough to crest) of up to 1.5 m.

To minimise the amount of rock cover required, it is proposed to lay the pipeline in the trough of the mega ripples where possible and then use a mass flow excavator to create a swathe ca. 5 m wide where it is necessary to cross a mega ripple. It is assumed that rock would then be placed along this length of the pipeline for protection and upheaval buckling mitigation.

The area of seabed impacted by this method would be within the worst case installation corridor calculated for the rock carpet scenario.

7.2.5 Installation of the WHPS, PLEM / Pigging Skid and Tie-in / Protection Structures

As described in Sections 3.4.2 and 3.4.3, there will be a loss of available seabed associated with the installation of the following structures:

- Industry standard fishing friendly WHPS, measuring approximately 18 m (L) x 18 m (W);
- Victory PLEM / Pigging Skid, measuring approximately 20 m (L) x 11 m (W);
- Victory PLEM / Tie-in Structure, measuring approximately 20 m (L) x 11 m (W);
- HTT2 Protection Structure, measuring approximately 20 m (L) x 11 m (W);
- Victory Umbilical Tie-in Structure, measuring approximately 20 m (L) x 11 m (W).

In total, therefore, the loss of available seabed associated with the installation of these structures is estimated to be 1,204 m^2.

Note, a protection structure will also be installed at HTT2 to protect the pipework and valves at the hot tap and a new GRP will be installed over the Edradour manifold. These will be like for like replacements of the structures already in place so will not result in the additional loss of seabed.

7.2.6 Tie-in Arrangements

As detailed in Table 3.9 (Section 3.4.5), it is estimated that the tie-in arrangements for the proposed Victory development will impact an area of seabed totalling 24,316 m^2 (0.02 km^2).

Tie-in spools and control jumpers will be protected by concrete mattresses. The mattress dimensions are yet to be determined, but are likely to be 6 x 3 x 0.3 m.

At the hot tap tee tie-in point, the existing protection (rock berm) over the HTT2 structure will be removed with a mass flow excavator, which will displace the rock adjacent to the HTT2 structure out to a distance of up to 10 m. The hot-tap will then be installed and a flexible line, 220 m in length, installed between HTT2 and the Victory PLEM / Tie-in Structure. The flexible line will be rock dumped and a combination of mattresses and rock will be used at the crossing locations. This work will be undertaken by TotalEnergies.

In order to access the Edradour manifold the existing protection (rock berm) over the Glass Fibre Reinforced Polymer (GRP) cover will need to be removed. As above, a mass flow excavator will likely be used to do this, which will relocate the rock out to a distance of up to 10 m. The GRP cover will then be recovered, the jumper installed and new GRP covers installed over the Edradour manifold and Victory tie-in structure. Rock will be placed over both the GRP covers and the jumper bundle. This work will also be undertaken by TotalEnergies.

7.2.7 Temporary Laydown Areas

Temporary laydown areas will be required at the Victory well and the hot tap tee locations. These will be used during the diving works for the deployment of diver tools (typically deployed in baskets with a footprint of approximately 2m x 2m) and short-term storage of tie-in pipe spools. The dimensions of each temporary laydown area will not exceed 100 m x 100 m, therefore in total 20,000 m^2 (0.02 km^2) of seabed may be temporarily disturbed.

7.2.8 Estimated Total Seabed Disturbance Area

The estimated total area of seabed disturbed from the development of the Victory field is 1,294,101 m^2 (1.29 km^2), as summarised in Table 7.1. Of this area, ca. 0.34 km^2 will be permanently disturbed by the subsea structures and protection material for the life of the Victory field development and beyond in the event the field is repurposed for carbon capture and storage.

Table 7.1: Estimated Extent of Seabed Disturbed from Development of the Victory Field

Aspect	Assumptions	Estimated Area of Seabed Disturbance	
		m^2	km^2
MODU anchoring (Section 7.2.1)	• 8 anchors (6 m by 6 m in dimension) • 8 mooring lines (ca. 1,100 m in length), with up to 75 % of the total length on the seabed, and a disturbance corridor width of ca. 10 m.	66,288	0.07
Deposit of drill cuttings and cement on the seabed (Section 7.2.2)	• Drill cuttings and cement will be deposited within a 560 m by 120 m oval-shaped area (based on worst case modelling for the Glenlivet exploration well)	850,000	0.85
Installation of pipeline and umbilical	• Pipeline: 16.2 km in length with a base rock berm width of 11 m (includes any disturbance from sand wave dredging)	332,293	0.33

Aspect	Assumptions	Estimated Area of Seabed Disturbance	
		m²	km²
(Sections 7.2.3 & 7.2.4)	• Umbilical: 18 km in length with a base rock berm width of 8 m • Disturbance within the boulder disposal corridor will be in the region of 21 m² • Temporary initiation anchor (6 m x 6 m) and initiation wire (500 m length x 10 m disturbance corridor)		
Installation of WHPS, PLEM / Pigging Skid and Tie-in / Protection Structures (Section 7.2.5)	• WHPS: 18 m (L) x 18 m (W) • Victory PLEM / Pigging Skid: 20 m (L) x 11 m (W) • Victory PLEM / Tie-in Structure: 20 m (L) x 11 m (W) • HTT2 Protection Structure: 20 m (L) x 11 m (W) • Victory Umbilical Tie-in Structure: 20 m (L) x 11 m (W)	1,204	0.001
Tie-in Arrangements (Section 7.2.6)	• Tie-in spools and control jumpers protected by concrete mattresses • 220 m flexible line between HTT2 and the Victory PLEM / Tie-in Structure protected by rock with mattresses also used at crossings • Removal and replacement of existing protection (rock berm) over the HTT2 structure and Edradour manifold	24,316	0.02
Temporary Laydown Areas (Section 7.2.7)	• 2 x areas - at the Victory well and the hot tap tee location – 100 m x 100 m	20,000	0.02
	Total:	**1,294,101**	**1.29**

7.3 Assessment of Impacts

7.3.1 MODU Anchoring

The total seabed disturbance area from MODU anchor and mooring lines is equal to circa. 66,288 m² (0.07 km²). As described in Section 7.2.1, a small area of seabed where each of the eight anchors are placed will be compressed as the anchors sink into the seabed. The movement of the mooring lines attached to the anchors as they sweep across the seabed will also cause localised direct abrasion damage to the habitats and species beneath for the duration of their deployment. In addition, when the anchors and chains are removed, scars, and sometimes anchor mounds, may be left on the seabed. In particular, anchor mounds may be formed during the retrieval of anchors in sedimentary areas, particularly where clay is present immediately beneath the surficial sediments.

The indirect effects of the anchoring include the re-suspension of sediments, and subsequent smothering of seabed habitats and species, which are likely to occur over a wider area as sediments are re-suspended and transported away from the immediate vicinity of the MODU anchoring area.

Seabed Sediments

The MODU anchoring will physically disturb the seabed sediment. There is little quantitative information available on the likely recovery time from the physical disturbance of anchor placement. However, indications are available from studies carried out for seabed disturbance from towed fishing gear (Løkkeborg, 2005). These suggest that it is likely that some level of recovery will occur in the sediments following anchoring operations. The longevity of the physical abrasion scars on the seabed is dependent on the type and energy of the local benthic environment. Seabed scars in higher energy, sandy or shallow environments may disappear within days or months of initial disturbance, whilst those in lower energy silty and deeper areas may still be faintly visible after 18 months.

As discussed in Section 4.2.2, seabed sediments within the Victory field development area have been identified as being sandy, showing small amounts of gravel and fines and a negligible silt and clay content (BSL, 2021a). The Victory field development is also located within an area of moderate energy characterised by complex current regimes (DECC, 2016). Consequently, seabed scars resulting from the Victory field development MODU anchoring have the potential to persist only in the short to medium term. During the 2012 seabed survey along the proposed Edradour pipeline and umbilical route, Fugro (2012a, 2012b) reported the presence of some deep anchor scars expanding laterally around the Edradour 206/4-2 exploration well. A rig was last on this well in 2011 (i.e. the prior year), indicating that anchor scars will likely persist in the area at least in the short term. The likelihood of anchor mounds forming is low.

The sensitivity of seabed sediments to the MODU anchoring as a result of the Victory development is therefore considered to be **Low**. The receptor is of local importance for sediment type, classed as Low value, and the overall resistance and resilience is High as recoverability is expected in the short to medium term given the sediment type and moderate energy environment. The magnitude of impact is predicted to be **Minor**; it will be limited to a very small area (ca. 0.07 km^2), with any change to baseline conditions predicted to be temporary in nature. Effects on seabed sediments from the MODU anchoring are therefore assessed as **Minor** and not significant.

Seabed Communities

The vulnerability of benthic species to the effects of physical disturbance and smothering (through the resuspension of sediments) is variable and dependant on the individual's mobility, physiology and ecology. Annelids dominated within the infaunal community, making up five of the top 10 ranked species. The most abundant species was the polychaete Owenia. The second and third most dominant taxa were the Cnidarian *Cerianthus lloydii* and Nematoda (BSL, 2021b).

No Annex I stony reef habitat or deep-sea sponge aggregations were identified in the MODU anchoring area (see Section 4.3.2).

Ocean quahog (*Arctica islandica*) is recorded as inhabiting the Faroe-Shetland Sponge belt, West of Shetland. No individuals were recorded in the macrofauna data at Victory, no potential relict shells were observed along the video transects and no live individuals or their distinctive siphons were noted during analysis of video footage and still photographs from the survey area (BSL, 2021a & BSL, 2021b). However, it is acknowledged that the species has previously been recorded in the area, with juveniles of *Arctica islandica* detected in three grab samples from the Glendronach survey, south of the Edradour manifold, with a total of four individuals recorded (MMT, 2019b). It is therefore possible that *Arctica islandica* could be present within the Victory development area.

The ocean quahog is of conservation importance due to its slow growth, late age of reaching reproductive maturity and vulnerability to disturbance (JNCC, 2014). The Feature Activity Sensitivity Tool (FeAST) indicates that ocean quahog has high sensitivity to sub-surface abrasions / penetration (i.e. MODU anchor placement) and low sensitivity to surface abrasion (i.e. MODU mooring line touchdown) (Marine Scotland, 2013; Tillin et al. 2010). The damage to this bivalve species is related to their body size, with larger specimens being more affected than smaller ones (Klein & Witbaard, 1993). For example, as a result of dredging in the southeast North Sea, only 10% of empty shells collected were undamaged (Klein & Witbaard, 1993).

Sessile epifauna, and a proportion of the infauna (animals that burrow into the sediment or form tubes within it) such as polychaete worms in the direct footprint area of the MODU anchoring pattern will be lost from compression and abrasion. However, recovery is expected to occur once the MODU departs the Victory development location. The re-colonisation of the impacted area can take place in a number of ways, including mobile species moving in from the edges of the area (immigration), juvenile recruitment from the plankton, or from burrowing species digging back to the surface. As described above, seabed scarring may persist in the short to medium term (1 – 5 years). However, the review by Løkkeborg (2005) notes that biological communities in physically disturbed seabed typically show recovery well before the scars themselves have disappeared. Further, Collie et al., (2000) examined impacts on benthic communities from bottom towed fishing gear and concluded that in general, sandy sediment communities were able to recover rapidly, although this was dependent upon the spatial scale of the impact. DECC (2011) suggests that, on the basis that seabed disturbance is qualitatively similar to the effects of wave action from severe storms, it is likely that sand and gravel habitat recovery from the processes of anchor scarring, anchor mounds and cable scrape is likely to be relatively rapid (1-5 years). Therefore, the relatively small number of anchor placements from the MODU for the Victory development will cause localised and temporary disturbance impacts and will not result in large scale changes in the benthic community.

The installation and retrieval of the MODU anchors, together with disturbance from the associated mooring lines, will result in sediment suspension and re-settlement outside of their direct footprint. Exposure to higher than normal loads of suspended sediments have the potential for negative impacts on habitats and species in the surrounding area. The re-settlement of sediments may result in the smothering of epifaunal species (Gubbay, 2003) with the degree of impact related to their ability to clear particles from their feeding and respiratory surfaces (Rogers, 1990). However, Defra (2010) states that impacts arising from sediment re-suspension are short-term (generally over a period of a few days to a few weeks). In addition, infaunal communities are naturally habituated to sediment transport processes and are therefore less susceptible to the direct impact of temporarily increased sedimentation rates. Depending on the sedimentation rates, infaunal species and communities can also work their way back to the seabed surface through blanket smothering (Neal and Avant, 2008).

Within the vicinity of the MODU anchoring area, the sediments are relatively coarse (sandy) in nature which means that plumes or re-suspended sediment will tend to re-settle quickly and will not be prolonged or affect large areas. Where sediment re-suspension does occur, the majority of species present, particularly the infaunal communities, are expected to recover in the short term (Defra, 2010).

In summary, the sensitivity of seabed communities to MODU anchoring as a result of the Victory development is considered to be **Low** as the habitats and species present are typical of this area. The receptors are of national importance and are of High value, and the overall resistance and resilience is Very High as recoverability is expected in the short to medium term. The magnitude of impact is predicted to be **Minor**; it will be limited to a very small area (ca. 0.07 km^2), with any change to baseline conditions predicted to be temporary in nature, occurring in the short to medium term (1 – 5 years). Effects on seabed communities from the MODU anchoring are therefore assessed as **Minor** and not significant.

The exception to this is the potential presence of ocean quahog, as the sensitivity of this bivalve species to sub-surface abrasions / penetration is **Very High**. Ocean quahog is on the OSPAR list of threatened and/or declining species and is therefore considered to have a Very High value, with Low resistance and resilience to MODU anchoring. However, given the limited area which would be disturbed by the MODU anchor and mooring lines (ca. 0.07 km^2) and the fact that this species was not recorded during the Victory environmental survey, the magnitude of impact is predicted to be **Minor**. Effects on ocean quahog from the MODU anchoring are therefore assessed as **Minor** and not significant.

Fish

The Victory development area is located within the spawning grounds for a number of fish species (refer to Section 4.3.3), including herring and sandeels which have a dependency on specific substrata for spawning and are therefore considered to be the most vulnerable to seabed disturbance.

Herring and sandeels are a commercially and ecologically important fish species which lay their eggs only in clean, sandy, and gravelly sediments. Sandeels are a key prey resource, particularly for seabirds, and an important link between zooplankton and top predators (Frederisken *et al*., 2006). Sandeels are also PMFs in Scottish waters (Tyler-Walters *et al*., 2016). Fish egg development and hatching success is vulnerable to the effects of sediment smothering and abrasion (DECC, 2016). However, as discussed in Section 4.3.3, while sandeels and sandeel spawning grounds may be present, the Victory field area is unlikely to offer prime habitat for this species. In addition, the area may not be suitable for herring spawning, given the water depth and the fact that the sediments samples from the Victory area have shown a minimum gravel content.

A number of studies have been conducted on the effects of sedimentation on fish egg development of commercially valuable fish species, particularly in relation to dredging operations. Results are variable with some studies demonstrating mortality of fish eggs when smothered by even a thin veneer of sediment (DOER, 2000), however many studies show no significant effects on fish egg and larval development and mortality (Auld and Schubel, 1978; Kiørboe *et al*., 1981; DOER, 2000).

The spawning grounds within which the Victory development area is located is part of wider spawning grounds within the vicinity of the Faroe-Shetland Channel and, as such, is not considered to be a key habitat for these fish species.

In summary, the sensitivity of spawning fish to the MODU anchoring as a result of the Victory development is considered to be **Low** as the species present are typical of the wider area. The receptors are of national importance and are of High value, and the overall resistance and resilience is Very High as recoverability is expected in the short term. The magnitude of impact is predicted to be **Negligible** with immeasurable changes in the baseline environment. Effects on spawning fish from the MODU anchoring are therefore assessed as **Negligible** and not significant.

7.3.2 Discharge of Drill Cuttings, Muds and Cement

As discussed in Section 7.2.2, as a worst case, it has been assumed that the WBM cuttings discharged from the Victory well (512 tonnes) will be deposited within an area of ca. 0.85 km^2, with the thickest part of the pile within ca. 50 m of the well. Any drill cuttings which may contain residues of reservoir hydrocarbons would also be deposited within this area, along with the cement discharged at the seabed when cementing the 30” conductor and 13 3/8” casing.

Research has shown that the effects on seabed fauna from the deposition of WBM cuttings and fine solids are usually subtle or undetectable, although the presence of drilling material at the seabed close to the drilling location (less than 500 m) is often detectable chemically (e.g. Cranmer, 1988, Neff *et al*. 1989, Hyland *et al*. 1994, Daan & Mulder, 1996). The main components of WBM are naturally occurring products (e.g. barite and bentonite clay), to which may be added various products to ensure the mud has suitable properties. The mud components are generally low risk and many chemical components are labelled as PLONOR (Pose Little or No Risk to the marine environment) (refer to Section 10.2.3). Ba in the form of barite is a weighting material used to increase the density of drilling muds and can contain measurable concentration of heavy metals as impurities, including cadmium, chromium, copper, lead, mercury, and zinc (NRC, 1983; McLeese et al., 1987). As a result of this, Ba in the seabed sediment can be used as an indication of previous drilling activities.

The Victory development area has previously been subject to drilling activities by well 207/01- 3, drilled by Texaco in 1977 and which encountered a thick, high quality sandstone reservoir containing lean, dry gas, and later by well 207/01a- 5 in 1996. Therefore, there could be some historical contamination of the sediments from these previous drilling operations. Well 207/01- 3 is located approximately 500 m from the proposed Victory development well location and the closest Victory grab sample station to well 207/01- 3 is approximately 180 m away. Well 207/01a- 5 is located approximately 1.6 km from the proposed Victory development well location and the closest Victory grab sample station to well 207/01a- 5 is located approximately 270 m away. However, the Victory 2021 environmental survey showed low levels of natural barium, ranging from 102 mg.kg-1 at station V_05 to 360 mg.kg-1 at station V_04 (see Section 4.2.2). These levels were comparable to the levels recorded during previous surveys at the Glenlivet and Edradour fields (Fugro, 2011; 2015; MMT, 2019a), which found mean concentrations of between 212 mg.kg-1 and 312 mg.kg-1. The low levels indicate little or no anthropogenic contamination from prior drilling activities in the area. The environmental baseline surveys conducted over Glenlivet, the Edradour Development Area, Benriach and Glendronach also found that Total Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons were all within background levels for the region, indicating little or no inputs from anthropogenic activity.

Seabed Sediments

Of the cuttings and mud ending up on the seabed, those discharged directly at the seabed will tend to form a pile around the well site, estimated to be within ca. 50 m of the well location, whilst those discharged from the rig will descend through the water column and be spread more thinly over a wider area of seabed. It is the top-hole discharges in particular which have the potential to alter the seabed topography and sediment structure. The material deposited will be a mixture of cuttings (i.e. material removed from the well), drilling mud (bentonite – a clay material) and cement with associated chemicals which differ in nature to the natural seabed sediments in the area.

Surface hole cuttings mounds in all but the deepest parts of the West of Shetland area will be dispersed, typically over a time scale of 1 – 10 years, mainly through the re-suspension and bedload transport due to tidal, storm and surge induced currents. Near seabed current velocities and sediment mobility in the West of Shetland area appear generally sufficient to prevent detectable local accumulation of cuttings (Wynn *et al*., 2002).

The sensitivity of seabed sediments to the discharge of drill cuttings, muds and cement as a result of the Victory development is therefore considered to be **Low**. The receptor is of local importance for sediment type, classed as <u>Low value</u>, and the overall <u>resistance and resilience is High</u> as seabed currents are likely to prevent local accumulations of cuttings or piles from persisting. The magnitude of impact is predicted to be **Minor** as the disturbance to seabed sediments will be localised to the Victory well location. Effects on seabed sediments from the discharge of drill cuttings, muds and cement are therefore assessed as **Minor** and not significant.

Seabed Communities

The accumulation of WBM drill cuttings, mud and cement at the Victory drilling location is likely to change the benthic community in the immediate area by burying some animals and impairing the feeding and respiration of others. It is expected that the communities in the immediate vicinity of the well will be lost, and that increased concentrations of suspended particles near the seabed may also impair respiratory and feeding processes, inducing metabolic stress and reducing growth and survival rates. Filter feeding organisms (for example, hydroids and bryozoans) that rely on suspended particles as a source of food are likely to be more vulnerable to the impacts of the drilling operations than the scavengers that rely on the deposition of suspended material. The net result therefore is likely to be a reduction in species diversity and production and a change in the species composition of the community, predicted to be within ca. 50 m of the wellhead. However, as the main impact is purely physical, it is anticipated that the sediment communities will begin to recover once the drilling operations have ceased. Re-colonisation of the impacted area can take place in a number of ways, including mobile species moving in from the edges of the area (immigration), usually more effective for the larger epifaunal species, juvenile recruitment from the plankton or from burrowing species digging back to the surface.

Considerable data has been gathered from the North Sea and other production areas, indicating that localised physical effects are the dominant mechanism of ecological disturbance, where WBM cuttings, muds and cements are discharged (DECC, 2011).

For example, a comprehensive desk study of the composition, environmental fates and biological effects of WBM cuttings and muds was prepared on behalf of the Petroleum Environmental Research Forum and the American Petroleum Institute by Neff (2005). The review, covering more than 200 publications and reports, concludes that effects of WBM cuttings piles on bottom living biological communities are caused mainly by burial and low sediment oxygen concentrations resulting from organic enrichment. Toxic effects, when they occur, are probably caused by sulphide and ammonia by-products of organic enrichment (DECC, 2011).

Daan and Mulder (1993) investigated the possible environmental effects of discharges of WBM cuttings from a single well site and reported there to be no short term adverse effects on the benthic community due to the presence of cuttings. A follow up study was carried out a year later which also revealed no adverse effects on the benthic community, and further indicated that there was no change to the sediment characteristics after 1 m distance from the discharge point.

Further evidence of recovery of seabed communities following drilling can be seen from the research work undertaken by AUMS (1987). A benthic environmental survey was undertaken in 1987 at three single well sites in the central North Sea (at depths of 102, 120 and 130 m respectively). The wells had been drilled five years prior to the survey using a WBM and a total of approximately 800 tonnes of cuttings had been deposited on the seabed at each location. The results of the survey indicated that, with the exception of a slightly elevated barium concentration, levels of sediment metals and hydrocarbons were similar to background concentrations. The analysis of the benthic fauna indicated that, even at sites closest to the wellheads, full recovery of the impacted sediments had taken place. These well sites were revisited by Oil and Gas UK (formerly UKOOA) in 2005 with analysis of the sediment samples showing that the area had recovered to be consistent with background conditions (Hartley Anderson Ltd, 2005).

In addition, field studies in the United States of America have shown that recovery of benthic communities impacted with water based drilling discharges is likely to be very rapid (i.e. within a few months) (Neff, 1982).

The habitats and species present at the proposed Victory well location are typical of the west of Shetland region. Annelids dominated within the infaunal community, making up five of the top 10 ranked species (BSL, 2021b). The most abundant species was the polychaete Owenia. The second and third most dominant taxa were the Cnidarian *Cerianthus lloydii* and Nematoda. Common components of the epifauna included Echinodermata (Asteroidea, Ophiuroidea, Spatangoida, *Porania pulvillus*), Arthropoda (Paguridae), and Mollusca (Buccinidae). No deep-sea sponge aggregations or stony reef habitat was observed in the vicinity of the Victory development well site (refer to Section 4.3.2).

Ocean quahog (*Arctica islandica*) were also not recorded during the Victory survey, but as noted above, there are mapped instances of the species occurring in the area and therefore it is possible they could be present. Ocean quahog burrow into the sediment, they use a short inhalant siphon which sits above the sediment surface for feeding and respiration (Taylor, 1976). Data taken from FeAST indicates that high rates of siltation may adversely affect ocean quahog, with the species having no tolerance and low recovery to the pressure and therefore a high sensitivity (Tillin *et al.* 2010; Marine Scotland, 2013). In addition, ocean quahog are known to be sensitive to the introduction of non-synthetic compound contamination (including heavy metals, hydrocarbons and produced water) (Marine Scotland, 2013). As such, there is a possibility that ocean quahog could be impacted by the discharge of cuttings potentially contaminated with hydrocarbons when drilling through the payzone, but it is calculated that only a small volume of oil would be discharged (up to 100 kg).

In summary, the sensitivity of seabed communities to the discharge of drill cuttings, muds and cement as a result of the Victory development is considered to be **Low** as the habitats and species present are typical of the west of Shetland region. The receptors are of national importance and are of High value, and the overall resistance and resilience is Very High as recoverability is expected in the short term. The magnitude of impact is predicted to be **Minor;** there will only be a temporary change to the baseline conditions, predicted to occur in the short to medium term, with any changes occurring within close proximity to the Victory well location. Effects on seabed communities from the discharge of drill cuttings, muds and cement are therefore assessed as **Minor** and not significant.

The exception to this is the potential presence of ocean quahog, as the sensitivity of this bivalve species to high rates of siltation is **Very High**. Ocean quahog is on the OSPAR list of threatened and/or declining species and is therefore considered to have a Very High value, with Low resistance and resilience to this type of pressure. However, given the limited area which would be disturbed by the cuttings pile and the fact that this species was not recorded during the Victory environmental survey, the magnitude of impact is predicted to be **Minor**. Effects on ocean quahog from the discharge of drill cuttings, muds and cement are therefore assessed as **Minor** and not significant.

Fish

As discussed in Section 4.3.3, a number of fish species are known to use the waters in the vicinity of the Victory development location, and some use the area as a spawning and / or nursery ground. Exposure to increased turbidity caused by the proposed operations may reduce the visual acuity of fish utilising the area potentially affecting foraging behaviour. Fish may also be temporarily displaced from their spawning and nursery areas due to the settlement of drill cuttings and muds on the seabed. However, given the localised area of impact and the mobile nature of the species, any displaced fish are likely to find foraging opportunities, as well as suitable spawning and nursey areas in adjacent locations.

It should be noted that benthic spawners, such as sandeels and herring are particularly vulnerable to seabed disturbance, with egg development and hatching success vulnerable to the effects of smothering (DTI, 2001). A number of studies have been conducted on the effects of sedimentation on fish egg development of commercially valuable fish species, particularly in relation to dredging operations. Results are variable with some demonstrating mortality of fish eggs when smothered by even a thin veneer of sediment (DOER, 2000) and other studies showing no significant effects on fish egg and larval development and mortality (Auld and Schubel, 1978; Kiørboe *et al*., 1981). However, those potential spawning grounds identified within the vicinity of the Victory development are part of wider spawning grounds around the North Sea and this area is not considered to be a critical habitat for these species. As discussed in Section 4.3.3, while sandeels and sandeel spawning grounds may be present, the Victory field area is unlikely to offer prime habitat for this species. In addition, the area may not be suitable for herring spawning, given the water depth and the fact that the sediments samples from the Victory area have shown a minimum gravel content.

In summary, the sensitivity of spawning fish to the discharge of drill cuttings, muds and cement as a result of the Victory development is considered to be **Low** as the species present are typical of the wider area. The receptors are of national importance and are of High value, and the overall resistance and resilience is Very High as recoverability is expected in the short term. The magnitude of impact is predicted to be **Negligible** with immeasurable changes in the baseline environment. Effects on spawning fish from the discharge of drill cuttings, muds and cement are therefore assessed as **Negligible** and not significant.

7.3.3 Installation of Subsea Infrastructure and Protection Material

The installation of the Victory pipeline, umbilical and subsea structures, together with the associated rock protection and concrete mattresses, will result in a direct impact on the seabed over an estimated area of 0.37 km^2 (see Section 7.2.8).

Seabed Sediments

Installation of the subsea infrastructure will result in the loss of some sandy sediment habitat from the area, and also the introduction of novel hard substrata. This will mostly comprise of rock protection berms over the pipeline and umbilical, as well as mattresses at the tie-in locations, together with smaller areas of coated steel from which infrastructure items are fabricated. The total area of long-term sandy sediment habitat loss is estimated to amount to approximately 0.34 km^2 for the life of the Victory field development and beyond in the event the field is repurposed for carbon capture and storage. This area is small in comparison to the area of similar habitat available across the wider area.

In addition, prior to the installation of the production pipeline, there may be a requirement to dredge the top of the sand wave crests along the initial 2.5 km section of the route from the Victory well location (see Section 7.2.4). To minimise disturbance to these features, it is proposed to lay the pipeline in the trough of the mega ripples, where possible; which is aided by the orientation of the sand waves. A mass flow excavator would then be used to create a swathe ca. 5 m wide where it is necessary to cross a mega ripple. It is unknown whether sand migration is active in this region; this will be reviewed during the detailed engineering phase, along with the potential for scouring.

The sensitivity of seabed sediments to the installation of subsea infrastructure and protection material as a result of the Victory development is therefore considered to be **Low**. The receptor is of local importance for sediment type, classed as Low value, and the overall resistance and resilience is High, as recoverability is expected in the short to medium term given the sediment type and moderate energy environment. The magnitude of impact is predicted to be **Substantial** as the impact will last the duration of the Victory field development and beyond in the event the field is repurposed for carbon capture and storage. Effects on seabed sediments from the subsea infrastructure installation activities are therefore assessed as **Minor** and not significant, particularly as the impacted sediment is characteristic of the wider area.

Seabed Communities

The seabed beneath the subsea infrastructure and protection material will be compacted. The sessile epifauna, and a proportion of the infauna (animals that burrow into the sediment or form tubes within it) such as polychaete worms in the direct footprint area of the Victory development field infrastructure will be lost from compression and abrasion. However, the consequences for most species in context to the wider region are expected to be short-lived as most of the smaller sedentary species (such as polychaete worms) have short lifecycles and high reproductive rates (Tillin and Tyler-Walters, 2014). Annelids dominated within the infaunal community, making up five of the top 10 ranked species. The most abundant species was the polychaete Owenia. The second and third most dominant taxa were the Cnidarian *Cerianthus lloydii* and Nematoda (BSL, 2021b).

The installation of the seabed infrastructure will also result in sediment suspension and re-settlement outside of their direct footprint, particularly when using the mass flow excavator. Exposure to higher than normal loads of suspended sediments have the potential for negative impacts on habitats and species in the surrounding area. The re-settlement of sediments may result in the smothering of epifaunal species (Gubbay, 2003) with the degree of impact related to their ability to clear particles from their feeding and respiratory surfaces (Rogers, 1990). However, Defra (2010) states that impacts arising from sediment re-suspension are short-term (generally over a period of a few days to a few weeks). In addition, infaunal communities are naturally habituated to sediment transport processes and are therefore less susceptible to the direct impact of temporarily increased sedimentation rates. Depending on the sedimentation rates, infaunal species and communities can also work their way back to the seabed surface through blanket smothering (Neal and Avant, 2008).

Within the vicinity of the proposed seabed infrastructure, the sediments are relatively coarse (sandy) in nature which means that plumes or re-suspended sediment will tend to re-settle quickly and will not be prolonged or affect large areas. Where sediment re-suspension does occur, the majority of species present, particularly the infaunal communities, are expected to recover in the short term (Defra, 2010). Furthermore, large scale field experiments by Dernie et al. (2003) investigated the response to physical disturbance of marine benthic communities within a variety of sediment types (clean sand, silty sand, muddy sand and mud). Of the four sediment types investigated, the communities from clean sands (such as those prevalent in the Victory field development area) had the most rapid recovery rate following disturbance and mud the slowest.

As noted above, the physical presence of the subsea structures, the rock protection over the pipeline and umbilical, as well as the mattresses at the tie-in locations, will introduce a new stable hard substrata to the area and over time a new rocky substrate habitat will become established. Ultimately, this new seabed feature is expected to be colonised by the same types of mobile and encrusting epifaunal animals already present on cobbles and boulders in the wider area.

On the whole, epifaunal coverage was low across the Victory survey area and was generally limited to encrusting species such as sponges (*Porifera*), Bryozoa and tube-building polychaetes (*Serpulidae*). Some erect fauna were observed in the form of Hydrozoa and sea anemones (*Actinauge* sp.) (BSL, 2021b). The Victory field falls within the theoretical range of the cold water coral *Lophelia pertusa* (refer to Section 4.3.2), which can be found growing opportunistically on seabed infrastructure and the legs of some platforms in the North Sea (Gass and Roberts, 2006). Therefore, it is possible that the introduction of a stable hard substrata in the area could encourage similar colonisation. However, no *L. pertusum* was observed within the Victory survey area and historic surveys in the wider area, including the Yell Sound pipeline survey and the Glenlivet Route 2 survey also found no colonies (living or dead) of *L. pertusa* (Fugro, 2009a and Fugro, 2011). Colonisation of steel structures on the seabed will be slowed by any protective wraps or antifouling applied, whereas colonisation of introduced rock deposits will be relatively uninhibited.

The introduction of novel hard substrata by the Victory field development is very small and localised (confirmed to an area of ca. 0.34 km^2) and, whilst it will represent a change to the benthic environment locally it is not expected to cause any widespread changes to the marine life present in the area.

In summary, the sensitivity of seabed communities to the installation of seabed infrastructure and protection material as a result of the Victory development is considered to be **Low** as the habitats and species present are typical of this area (note, the impact to protected habitats and species is discussed separately below). The receptors are of national importance and are of <u>High value</u>, and the overall <u>resistance and resilience is Very High</u> as recoverability is expected in the short term. The magnitude of impact is predicted to be **Substantial** as the impact will last the duration of the Victory field development and beyond in the event the field is repurposed for carbon capture and storage. Effects on seabed communities from installation of seabed infrastructure and protection material are therefore assessed as **Minor** and not significant, given that any change to the benthic environment will be local and is not expected to cause any widespread changes to the marine life present in the area.

Protected Habitats and Species

The Victory field is situated in an area identified as having the potential for 'stony reef' habitats (JNCC, 2021c; JNCC, 2016b). 'Stony reef' is listed as a protected habitat in Annex I of the EU Habitats Directive. Stony reefs have a limited tolerance to direct physical impact, with recovery not expected for an extended period. A stony reef assessment (after Irving, 2009) for the Victory development area found no characteristics of 'medium' reef. One location at the southern end of the HTT2 pipeline route which was classified as 'Low' on the overall reefiness matrix. However, 'low' reef was not evident throughout this habitat. Therefore, the pipeline installation activity has the potential to disturb one isolated area of 'Low' stony reef habitat. Other surveys in the wider area have also recorded this habitat type, as discussed in Section 4.3.2. Corallian therefore commit to acquire further environmental data along the pipeline route, as required, during the detailed engineering surveys scheduled to be undertaken in 2023, to reconfirm the 2021 survey results and aid micro siting of the pipeline, thereby avoiding any significant impacts to this habitat type.

Ocean quahog is recorded as inhabiting the Faroe-Shetland Sponge belt, West of Shetland; however, no individuals were recorded in the macrofauna data at Victory, no potential relict shells were observed along video transects and no live individuals or their distinctive siphons were noted during analysis of video footage and still photographs from the survey area (BSL, 2021b). However, it is acknowledged that the species has previously been recorded in the area. The ocean quahog is highly sensitive to physical pressures as discussed in Sections 7.3.1 and 7.3.2; therefore, the installation of the Victory development subsea infrastructure has the potential to cause direct mortality to ocean quahog. The introduction of a new stable hard substrata to the area will also cause a direct reduction in suitable seabed habitat that could support ocean quahog, with Tillin et al. (2010) reporting the species as having a high sensitivity to physical change to another seabed habitat type. Any impacts will, however, be in a very localised area (ca. 0.37 km^2), such that any effects on the population of ocean quahog in the wider West of Shetland region are not predicted to be significant.

Deep sea sponge aggregations are recorded from the northern Scottish slope of the Faroe-Shetland Channel (OSPAR, 2010). Although they are usually found in water depths greater than 250 m, significant sponge aggregations can be found as shallow as 30 m, and therefore the Victory field location has the potential to host sponge aggregations. FeAST indicates that deep sea sponge aggregations are highly sensitive to physical pressures due to the fragile nature of the sponges and low recovery rates (Tillin et al., 2010; Marine Scotland, 2013). Smothering can also damage sponges by clogging their complex filtering apparatus which they use to feed (Hogg et al., 2010),

During the Victory environmental survey, the majority of sponges observed were encrusting sponges attached to cobbles and boulders. Only two instances of non-encrusting sponges were observed throughout the survey area, deemed not significant enough to be classified as a deep-sea sponge aggregation. Of the other surveys undertaken in the wider area, deep sea sponge aggregations were only identified in deeper water depths towards the Laggan field (refer to Section 4.3.2). In addition, a potential area of deep-sea sponge aggregations was found in the north western parts of the Glendronach survey area, to the south of Edradour, although the sponges had limited fauna associated with them (MMT, 2019b).

Installation of the Victory development subsea infrastructure and protection material is therefore not expected to significantly disturb existing deep sea sponge aggregations in the area.

Fish

The Victory development area is located within the spawning grounds for a number of fish species, including herring and sandeels which have a dependency on specific substrata for spawning and are therefore considered to be the most vulnerable to seabed disturbance (refer to Section 4.3.3).

A number of studies have been conducted on the effects of sedimentation on fish egg development of commercially valuable fish species, particularly in relation to dredging operations. Results are variable with some studies demonstrating mortality of fish eggs when smothered by even a thin veneer of sediment (DOER, 2000), however many studies show no significant effects on fish egg and larval development and mortality (Auld and Schubel, 1978; Kiørboe *et al*., 1981; DOER, 2000).

The physical presence of the Victory development subsea infrastructure, rock protection and mattresses on the seabed will provide a new stable hard substrata, resulting in the long term loss of seabed habitat within an area of ca. 0.34 km^2. However, the spawning grounds within which the Victory development area is located are part of wider spawning grounds within the vicinity of the Faroe-Shetland Channel and, as such, is not considered to be a key habitat for these fish species. As discussed in Section 4.3.3, while sandeels and sandeel spawning grounds may be present, the Victory field area is unlikely to offer prime habitat for this species. In addition, the area may not be suitable for herring spawning, given the water depth and the fact that the sediments samples from the Victory area have shown a minimum gravel content.

In summary, the sensitivity of spawning fish to the installation of seabed infrastructure and protection material as a result of the Victory development is considered to be **Low** as the species present are typical of the wider area. The receptors are of national importance, with some on the IUCN Red List of Threatened Species, and are therefore of High value, but the overall resistance and resilience is Very High as recoverability is expected in the short term. The magnitude of impact is predicted to be **Negligible** with immeasurable changes in the baseline environment. Effects on spawning fish from the installation of seabed infrastructure and protection material are therefore assessed as **Negligible** and not significant.

7.4 Mitigation Measures

Seabed disturbance impacts as a result of the proposed Victory field development will be minimised by the implementation of the following mitigation measures:

- Use the minimum appropriate number of MODU anchors and length of anchor chains to maintain stability and integrity.
- A full Chemical Hazard Assessment and Risk Management (CHARM) assessment of the proposed chemicals to be used and discharged, as required under the Offshore Chemicals Regulations 2002 (as amended), will be undertaken during the permitting process prior to drilling operations commencing and, as part of chemical selection and assessment process, less hazardous alternatives will be sought in preference for any chemicals identified to be high risk (e.g. those with substitution warnings).
- Drill cuttings to be passed through the cuttings cleaning system on the MODU prior to discharge.
- A ROV and chemical dye will be used to monitor cement returns when cementing the 30 inch conductor to help ensure the volume of cement discharged to the seabed is kept at a minimum.
- Corallian commit to acquire further environmental data along the chosen pipeline and umbilical routes, as required, during the detailed engineering surveys scheduled to be undertaken in 2023.
- During the detailed design phase of the project, use of a weighted pipeline will be investigated, which may reduce the worst case quantity of rock to be deposited.
- Working corridors will be minimised as far as possible.
- Any boulders removed from the pipeline and umbilical lay corridors will be placed appropriately on the seabed to avoid a snag hazard and their as-left position recorded.
- To minimise disturbance to the sand waves features at the Victory location, it is proposed to lay the pipeline in the trough of the mega ripples, where possible; which is aided by the orientation of the sand waves.
- Disturbance of the existing protection (rock berm) over the HTT2 structure and Edradour manifold will be minimised, as far as practicable.

- Conduct pre-rock deposit survey to determine exact locations and pre-deposit profiles of target areas. Use survey results to devise a rock-deposit plan.
- Monitoring of integrity of subsea infrastructure, including the pipeline / umbilical and stabilisation material throughout production operations and taking remedial action, if required. However, based on TotalEnergies' experience in this area West of Shetland, subsea integrity is not expected to be an issue.
- Minimise amount of deposited material whilst still achieving the required level of stabilisation / protection.

7.5 Residual Effects

In summary, no significant residual effects on seabed sediments, seabed communities or fish are predicted as a result of disturbance to the seabed during the life of the Victory field development. The maximum total area of seabed that will be directly impacted by the Victory development is estimated at around 1.29 km^2. This is a relatively small area in comparison to the seabed available in the West of Shetland region, with similar water depths, sediment types and benthic communities. In addition, a large proportion of the total seabed disturbance area (ca. 75%) is attributed to MODU anchoring, discharge of WBM drill cuttings, muds and cement, disturbance from pipeline and umbilical initiation anchor and wire and temporary lay down areas where only temporary short to medium term effects are predicted. It is, however, recognised that some aspects associated with the Victory development (i.e. installation of the subsea structures, pipeline and umbilical and associated protection material) will have longer term impacts on sediment communities, due to permanent habitat change, although direct physical injury of benthic species will only occur when the infrastructure or material is first placed on the seabed.

7.6 Transboundary Impacts

The environment within which the proposed Victory development area is located is relatively stable compared to other more heterogeneous and transient areas such as the southern North Sea. As such, and given the fact that the Victory development area is located approximately 110 km to the south east of the UK/Faroe median line, no transboundary impacts on the seabed are anticipated.

7.7 Cumulative Impacts

Effects of seabed disturbance resulting from oil and gas activities will be cumulative to those of other activities, particularly trawling activities. The Victory field development is located within an area of high fishing intensity for demersal species, and as such, it is considered that the contribution of other forms of seabed disturbance, such as offshore installation activities, are minor in comparison to the direct physical effects of fishing (DECC, 2016).

The proposed Victory development also lies within an area of fairly low oil and gas activity (refer to Section 4.4.3) and will tie back into the existing GLA pipeline located approximately 17 km south east of Victory. In addition, the closest producing surface infrastructure is the Clair Ridge platform located approximately 41 km south west of the proposed Victory development well. As these fields are currently producing, the only activities that could result in cumulative seabed disturbance impacts are in the event of any maintenance construction work (e.g. spot rock-deposits) or incremental drilling activity. As such it is unlikely that there will be any significant cumulative impacts with respect to seabed disturbance and ongoing production activities.

Corallian is aware that Equinor's proposed West of Shetland Rosebank field development is scheduled for a key financial investment decision in 2022. If a decision is made to proceed with the development, there is a possibility that field development activities for Rosebank could be ongoing at the same time as Victory. The Rosebank field development is anticipated to directly impact a seabed area covering 0.46 km^2. However, Rosebank is located approximately 130 km north west of the Shetland Islands and is in much deeper water than Victory at approximately 1,100 m. The gas pipeline will run in a south-east direction from the Rosebank field for approximately 236 km, before tying into the SIRGE pipeline in the northern North Sea. This route lies to the south of BP's Clair field and is therefore some distance from the proposed Victory development. Given the mitigation measures which will be in place for Victory, significant cumulative impacts with respect to seabed disturbance are therefore not predicted.

8 Underwater Noise Emissions

8.1 Introduction

Marine fauna, including fish and marine mammals have developed a range of complex mechanisms for both emitting and detecting underwater noise signals that allow them to communicate, avoid predators and other perceived dangers, locate food and mates, and navigate (Richardson *et al*., 1995; DOSITS, 2017). Sounds are particularly important for intra-species communication as they can convey significant amounts of information quickly and over great distances (DOSITS, 2017). As such, many marine species are vulnerable to anthropogenic noises that may disrupt their ability to perceive their surrounding environment.

Underwater noise emissions generated from the proposed development of the Victory field therefore have the potential to disturb, or cause injury to, sensitive marine fauna. This section assesses whether the underwater noise generated by the following activities has the potential to result in a significant impact on fish or marine mammals:

- Drilling activity (e.g. rotating machinery);
- Vessel operations (e.g. use of propellers / DP thrusters);
- Piling operations to install WHPS, PLEM / pigging skid and tie-in / protection structures.

In addition, the Conservation of Offshore Marine Habitats and Species Regulations 2017 make it an offence to deliberately capture, kill, injure or disturb any European Protected Species (EPS; species listed in Annex IV of the Habitats Directive, including all species of cetaceans), in such a way that is likely to:

a. Impair their ability to survive, to breed or reproduce, or to rear or nurture their young; or in the case the case of animals of a hibernating or migratory species, to hibernate or migrate;

b. Affect significantly the local distribution or abundance of the species to which they belong.

This section also assesses if the above listed activities, either alone or in combination with other activities, are likely to cause an offence involving an EPS.

8.2 Assessment of Impacts

8.2.1 Victory Noise Sources

Drilling Activity

There will be some sound and vibration associated with the proposed drilling operations. This sound will propagate from any rotating machinery such as generators, pumps and the drilling unit and risers (McCauley, 1994). The MODU used to drill the Victory well will be anchored in place, thereby minimising the requirements for DP thrusters. Source levels associated with a typical semi-submersible drilling rig may be up to 170 dB re 1µPa @ 1m (Richardson *et al*., 1995), although other studies have recorded slightly lower levels at 154 dB re 1µPa @ 1m (measured from the SEDCO 708 semi-submersible MODU in water depths of 114 m) (Greene, 1986 cited in Genesis, 2011). The noise produced will therefore be of a relatively low level, although it will be continuous and generated for long periods throughout the drilling phase.

Vessel Operations

In addition to the MODU, a variety of other vessels will be mobilised to develop the Victory field, including the ERRV, supply vessels, AHV and tugs during the drilling phase and pipelay reel-lay vessel, umbilical lay vessel, rock dump vessel, DSV / MSV and survey and utility vessels during the installation and commissioning phase. Large vessels (greater than 100 m length) have sound pressure levels within the range of 180-190 dB re 1 µPa @ 1m, whilst most support vessels, assuming a medium-size ship (50 – 100 m in length), have sound pressure levels within the range of 165-180 dB re 1 µPa @ 1m (OSPAR 2009b). The highest sound levels are expected from short-term energy-demanding activities, for example when using DP thrusters to position vessels on location (Genesis, 2011). The majority of the acoustic energy from vessels is below 1 kHz, typically within the 50-300 Hz range, although cavitation from propellers produces sounds at frequencies of between 1 kHz and 125 kHz (Genesis 2011; Hermannsen *et al.* 2014).

Piling Operations

The foundation design of the WHPS, PLEM / pigging skid and tie-in / protection structures are subject to further engineering studies. However, as a worst case scenario for the purposes of this ES, it is assumed that four x 914 mm (36 inch) diameter piles will be used to provide a foundation for each structure.

The piles will be secured into the seabed using a maximum hammer blow energy of 50 kJ, with each pile taking up to one hour to install, although only four piles will be installed in any 24 hour period. At the beginning of the operations each pile will protrude around 18 m from the seabed, but once installed only 4 m will be present above the seabed.

The maximum source level during installation is predicted to be 207.9 dB re 1 µPa @ 1 m for unweighted SPLpeak (derived from Subacoustech's impact piling noise measurement database) and the unweighted single strike SEL source level is predicted to be 186.0 dB re 1 µPa2s @ 1 m (Subacoustech, 2021). Note that these "source levels" are really "apparent source levels," as they would appear at great distance for the purposes of environmental modelling. A real noise level measured 1 m from a foundation pile struck by a hammer is extremely complex and less useful for modelling at long range.

Given the characteristics of the proposed piling operations and the impulsive nature of the sound produced, this activity will result in the largest impact to marine fauna. Therefore, underwater sound propagation modelling has been conducted to estimate the extent of potential injury or behavioural disturbance to marine mammals and fish from the proposed piling operations.

8.2.2 Underwater Noise Transmission

As sound spreads underwater, it decreases in intensity (attenuates) with distance from the source. The rate of attenuation is affected by sound absorption or scattering by organisms in the water column, reflection or scattering of the sound wave at the seabed, which varies depending on sediment type, and the temperature, pressure, water column stratification, salinity and even weather (Munk and Zachariasen, 1991; Richardson *et al.,* 1995). It also reflects and scatters at the sea surface, which varies depending on sea state conditions. Consequently, actual sound transmission has considerable temporal and spatial variability that is difficult to quantify.

For this project, in order to estimate the received sound pressure levels from the proposed piling operations in the waters surrounding the proposed Victory development, Subacoustech was commissioned to undertake underwater sound propagation modelling in accordance with the recommendations in the National Physical Laboratory Good Practice Guide 133 for Underwater Noise (Robinson *et al.,* 2014).

Modelling of underwater noise is complex and can be approached in several different ways. For this modelling, Subacoustech have chosen to use a numerical approach that is based on two different solvers using the dBSea modelling software:

- A parabolic equation (PE) method for lower frequencies (12.5 Hz to 100 Hz); and
- A ray tracing method for higher frequencies (125 Hz to 100 kHz).

The PE method is widely used but has computational limitations at high frequencies. Ray tracing is more computationally efficient but is not suited to low frequency noise (Etter, 2013).

A wide array of input parameters including bathymetry, sediment data, sound speed and source frequency content were input into the model to ensure the results are as accurate as possible (Subacoustech, 2021). A summary of the key input parameters is provided in Table 8.1.

Table 8.1: Modelling Input Parameters

Input Parameter	Victory Piling Data
Modelling Location	60° 58’ 10.163” N; 01° 54’ 31.955” W (ED50, UTM Zone 30N)
Pile Characteristics	Tubular piles, measuring 914 mm (36 inch) in diameter
Piling Duration	One hour per pile
Max Source Level	Unweighted SPLpeak: 207.9 Db re 1 µPa @ 1 m Unweighted single strike SEL: 186.0 Db re 1 µPa2s @ 1 m
Max Hammer Blow Energy	50 Kj
Piling Ramp Up	15 Kj (30%) for 5 minutes; 30 Kj (60%) for 5 minutes; Gradually increase from 30 Kj to 50 Kj over 30 minutes 50 Kj (100%) for the remaining duration of piling (20 minutes).
Strike Rates	65 pile strikes per minute

The results of the modelling are summarised below, with reference to the criteria used to assess the noise impact on relevant marine species; Popper et al. (2014) for fish and Southall et al. (2019) for marine mammals. Note, the Southall et al. (2019) paper is effectively an update of the previous Southall et al. (2007) paper and provides identical thresholds to those from the National Marine Fisheries Service (NMFS) (2018) guidance for marine mammals.

It should be stressed that while the modelling results present specific ranges at which impact thresholds are met, these ranges should be considered worst case in determining whether receptors will experience environmental effects during the proposed piling operations.

8.2.3 Potential Impacts on Fish

Sounds produced by fish are predominantly related to reproduction or conveying territorial aggression or predation (DOSITS, 2017). As such, many fish species have developed sensory mechanisms for detecting, locating and interpreting underwater sounds. Hearing ability is highly variable between fish species. Species with a connection between the inner ear and the swimbladder, a gas-filled organ primarily used for buoyancy, are more sensitive to sound (Hawkins, 1993; Moyle and Cech, 2004; Popper, 2012). Fish may tentatively be separated into:

- Category I - Fish with no swim bladder or other gas volume (particle motion detectors), such as flatfish, mackerel and sharks, skates and rays (Myrberg, 2001) and sandeels (Mason, 2013). These species tend to have relatively low auditory sensitivity;
- Category II - Fish with a swim bladder or other gas volume, and therefore susceptible to barotrauma (injury caused by increased air or water pressure), but where the organ is not involved in hearing (particle motion detectors);
- Category III - Fish with a swim bladder or other gas volume, and therefore susceptible to barotrauma, where the organ is also involved in hearing (sound pressure and particle motion detectors), such as cod and herring and relatives (Hawkins, 1993; Popper *et al.,* 2014; DOSITS, 2017).

The adult fish community in the vicinity of the Victory field development is dominated by demersal species such as saithe, monkfish (anglerfish), cod, witch, haddock and whiting (see Section 4.3.3). Many demersal species have a small or reduced swim bladder or a swim bladder that is not in close proximity, or mechanically connected to the ears and would therefore be classified as Category II fish. These species therefore tend to have relatively poor auditory sensitivity, and generally cannot hear sounds at frequencies above 1 kHz (DOSITS, 2017).

Physiological damage to fish eggs and larvae is also of particular concern, since unlike adult fish they are unable to move away from a noise source and are therefore at greater risk of mortality (Turnpenny and Nedwell, 1994). Species that may spawn within the Victory development area include herring, haddock, lemon sole, Norway pout, saithe, sandeels (*Ammodytes* spp.) and whiting (see Section 4.3.3).

Potential effects on fish from intense noise sources, such as those from piling, range from behavioural changes including fish moving away from an area or ceasing feeding, to physiological changes such temporary hearing loss, tissue damage or even death (DOSITS, 2017). For this application, the effects of noise on fish have been assessed using the unweighted SPL_{peak} and SEL_{cum} criteria from Popper *et al.* (2014) for pile driving (see Table 8.2).

Table 8.2: Assessment criteria for species of fish from Popper et al. (2014) for pile driving stimuli

Criteria	Threshold[1]			
	Category I fish	Category II fish	Category III fish	Eggs and larvae
Mortality and Potential Mortal Injury				
Unweighted SPL_{peak}	>213 dB	>207 dB	>207 Db	>207 dB
Unweighted SEL_{cum}	>219 dB	210 dB	207 dB	210 dB
Recoverable Injury				
Unweighted SPL_{peak}	>213 dB	>207 dB	>213 dB	See Table 8.3
Unweighted SEL_{cum}	>216 dB	203 dB	203 dB	See Table 8.3
Temporary Threshold Shift (TTS)				
Unweighted SEL_{cum}	>>186 dB	>186 dB	186 dB	See Table 8.3

[1] Where insufficient data on impacts are available (which is the case for masking and behavioural effects from impact piling), qualitative criteria have been given, summarising the effect of the noise as having either a high, moderate or low effect on a receptor in either the near-field (tens of metres), intermediate field (hundreds of metres), or far-field (thousands of metres). These qualitative effects are reproduced in Table 8.3 and are not investigated further.

Table 8.3: Summary of the qualitative effects on fish from pile driving stimuli from Popper et al (2014) (N = Near-field, I = Intermediate-field, F = Far-field)

Fish Category	Recoverable Injury	TTS	Masking	Behaviour
Category I fish	See Table 8.2	See Table 8.2	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Category II fish	See Table 8.2	See Table 8.2	(N) Moderate (I) Low (F) Low	(N) High (I) Moderate (F) Low
Category III fish	See Table 8.2	See Table 8.2	(N) High (I) High (F) Moderate	(N) High (I) High (F) Moderate
Eggs and larvae	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) Moderate (I) Low (F) Low

Both fleeing and stationary animal models (i.e. where the receptor remains static through the noise exposure) have been used to cover the SELcum criteria for fish. It is recognised that there is limited evidence for fish fleeing form high level noise sources in the wild, and it would reasonably be expected that the reaction would differ between species. Most species are likely to move away from a sound that is loud enough to cause harm (Dahl et al., 2015; Popper et al., 2014), some may seek protection in the sediment and others may move elsewhere in the water column. For those species that flee, a 1.5 ms-1 flee speed has been chosen for this study, which is relatively slow in relation to data from Hirata (1999) and thus is considered somewhat conservative.

Although it is feasible that some species will not flee, those that are likely to remain are thought more likely to be benthic species without a swim bladder; these are the least sensitive species. For example, from Popper et al. (2014): “There is evidence (e.g., Goertner et al., 1994; Stephenson et al., 2010; Halvorsen et al., 2012) that little or no damage occurs to fishes without a swim bladder except at very short ranges from an in-water explosive event. Goertner (1978) showed that the range from an explosive event over which damage may occur to a non-swim bladder fish is in the order of 100 times less than that for swim bladder fish."

Stationary animal model has been included in this study, based on research from Hawkins et al. (2014) and other modelling for similar projects. However, basing the modelling on a stationary (zero flee speed) receptor is likely to greatly overestimate the potential risk to fish species, assuming an individual would remain in the high noise level region of the water column, especially when considering the precautionary nature of the parameters already built into the cumulative exposure calculation.

Table 8.4 gives the predicted maximum, mean and minimum impact ranges for species of fish as a result of the underwater noise generated from the proposed pile driving operations, using the Popper et al. (2014) criteria.

Table 8.4: Summary of Injury and TTS Ranges using the Popper et al. (2014) criteria for fish (Subacoustech, 2021)

Popper et al. (2014) Injury criteria (see Table 8.2)	Injury Range		
	Maximum (m)	**Mean (m)**	**Minimum (m)**
Unweighted SPLpeak			
213 dB re 1 µPa	<50	< 0	<50
207 dB re 1 µPa	<50	<50	<50
Unweighted SELcum criteria (fleeing)			
219 dB re 1 µPa²s	<50	<50	<50
216 dB re 1 µPa²s	<50	<50	<50
210 dB re 1 µPa²s	<50	<50	<50
207 dB re 1 µPa²s	<50	<50	50
203 dB re 1 µPa²s	<50	<50	<50
Unweighted SELcum criteria (stationary)			
219 dB re 1 µPa²s	<50	<50	<50
216 dB re 1 µPa²s	60	50	50
210 dB re 1 µPa²s	440	400	360
207 dB re 1 µPa²s	760	690	620
203 dB re 1 µPa²s	1,900	1,400	1,100
Popper et al. (2014) TTS criteria (see Table 8.2)	**TTS Impact Range**		
	Maximum (m)	**Mean (m)**	**Minimum (m)**
Unweighted SELcum criteria (fleeing)			
186 dB re 1 µPa²s	7,400	4,800	3,600
Unweighted SELcum criteria (stationary)			
186 dB re 1 µPa²s	17,000	12,000	9,500

Fish with swim bladders are the most sensitive to impact piling noise, however, it can be seen from Table 8.4 that all injury ranges are predicted to be less than 50 m for the parameters modelled when considering the unweighted instantaneous SPLpeak and fleeing receptors using the unweighted

SELcum criteria. Injury ranges of up to 1.9 km are predicted for stationary receptors when considering the unweighted SELcum criteria for fish with swim bladders (203 dB re 1 µPa2s). The largest ranges are predicted for TTS (186 dB re 1 µPa2s), with predicted ranges of up to 7.4 km for fleeing receptors and 17 km for stationary receptors. However, it is worth noting that that a stationary receptor is likely to be over-precautionary as it involves a receptor staying in the same location throughout the entire piling operation (Subacoustech, 2021).

Most noise produced by fish is related to reproduction, therefore many fish are more receptive and more sensitive to introduced noise during reproductive periods and spawning events. Disturbance to fish during key lifecycle events may have greater impacts at a population level as it could deter individuals away from crucial habitats. The waters surrounding the Victory field have been identified as spawning and nursery grounds for a number of fish species throughout the period when the proposed operations are scheduled to occur (refer to Section 4.3.3). Category III fish which may use the Victory Development location for nursery or spawning, and are more at risk of impact due to the use of a swim bladder for hearing include cod (although the area may not provide ideal spawning habitat for the species), herring, ling and whiting. Detailed scheduling for the proposed piling operations has not yet been determined; however operations could be ongoing at some point during July to October 2024. Fishing species spawning in the area during this period include herring and lemon sole, although due to the minimum gavel content of the sediments at Victory the area may not be ideal spawning habitat. There are also high intensity nursery periods for Anglerfish (monkfish), blue whiting and mackerel during this period. However, for the majority of fish species in the area with spawning and / or nursery periods that overlap with the Victory field development area, the area likely to be impacted is considered to represent only a small proportion of the spawning and nursery grounds available to each fish species. In addition, as the proposed piling operations will be temporary (occurring for less than a week) they will not be conducted over an entire spawning / nursey period for any one species and are therefore unlikely to result in significant disruption.

The sensitivity of fish to the underwater noise generated during the proposed piling operations is therefore considered to be **High**; the receptor is of very high value as some species in the area are listed as PMFs in Scottish waters and / or on the International Union for the Conservation of Nature (IUCN) Red List of Threatened Species (see Section 4.3.3), but has some tolerance / ability to adapt to effects (High resistance and resilience). Based on the assessment as detailed above, the magnitude of impact is predicted to be **Minor** as any impacts will be in fairly close proximity to the source and the period during which fish may encounter sound from the proposed operations is relatively short, with piling operations anticipated to be ongoing for up to one week. With the implementation of a piling soft-start procedure it is expected that any fish in the area would disperse to areas where injury or mortality would not occur. Furthermore, if fish are disturbed by sound, evidence suggests they will return to an area once the activity causing the disturbance has ceased (Slabbekoorn *et al.,* 2010). Effects on fish are therefore considered to be **Minor** and not significant. The mitigation measures which will be implemented, as outlined in Section 8.3, will help ensure any impacts to fish are minimised as much as possible.

Popper et al. (2014) has also reviewed the effects of vessel sound on fish. They noted that there is no direct evidence of mortality or potential mortality to fish from vessel sound or other continuous sound sources, such as that generated from drilling activities. It was concluded that the likelihood of sound from vessels causing mortality or injury to fish was remote, even for fish in close proximity to vessels. There is the possibility that sound from vessels may cause some behavioural disturbance to fish, but given that fish in the West of Shetland are accustomed to the presence of vessels in the area, any impacts to fish as a result of underwater noise from vessel operations are assessed as **Negligible**. In addition, there is a range of evidence from underwater video inspections of North Sea drilling and production platform jackets that show fish species, especially gadoids such as cod and saithe, swimming calmly in the immediate vicinity of the installations (Fujii, 2015).

It is also noted that fish are an important food source for seabirds and marine mammals. As such, seabirds and marine mammals could be indirectly impacted by changes in the abundance of fish; however, given the relatively small impact range for fish, indirect impacts on seabirds and marine mammals are not predicted to be significant.

8.2.4 Potential Impact on Marine Mammals

Introduction

Marine mammals, in particular, cetaceans, rely almost exclusively on sound for navigating, foraging, breeding and communicating (Clark, 1990; Edds-Walton 1997; Tyack and Clark, 2000). The extent to which intense underwater sound might adversely impact a species is dependent upon the incident sound level, sound frequency, and duration of exposure and/or repetition rate of the sound wave.

The Southall et al. (2019) guidance groups marine mammals into categories of similar species and applies filters to the unweighted noise to approximate the hearing sensitivities of the receptor. The hearing groups given in Southall et al. (2019) are summarised in Table 8.5, along with the corresponding marine mammal species that have been recorded West of Shetland (some of these are resident, whilst others use the Faroe-Shetland Channel as a migratory pathway).

Table 8.5: Functional Marine Mammal Hearing Groups That May Be Present Within the Victory Field Development Area (Southall *et al.*, 2019)

Functional Group	Estimated Auditory Bandwidth	Species Represented in the Victory Field Development Area [1]
Low-frequency (LF) cetaceans	7 Hz – 35 kHz	Minke whale, humpback whale, fin whale, sei whale
High-frequency (HF) cetaceans	150 Hz – 160 kHz	White-sided dolphin, white-beaked dolphin, common dolphin, Risso's dolphin, striped dolphin, long-finned pilot whale, sperm whale, killer whale, northern bottlenose whale, beaked whales
Very High-frequency (VHF) cetaceans	275 Hz – 160 kHz	Harbour porpoise
Phocid carnivores in water (PCW)	50 Hz to 86 kHz	Harbour seal, Grey seal

[1] See Section 4.3.5

Physiological Impacts

When marine mammals are exposed to intense sound, an elevated hearing threshold may occur, known as a threshold shift (TS). If the hearing threshold returns to the pre-exposure level after a period of time, the TS is known as a temporary threshold shift (TTS). If the threshold does not return to the pre-exposure level, it is known as a permanent threshold shift (PTS) and is considered to result in injury (Finneran *et al.,* 2000; Southall *et al.,* 2007).

Southall *et al.* (2019) gives individual criteria for marine mammal hearing groups based on whether the noise is considered impulsive or non-impulsive. The study categorises impulsive noises as having high peak sound pressure, short duration, fast rise-time and broad frequency content at source, and non-impulsive sources as steady-state noise. Piling is considered an impulsive noise and drilling, as well as other more low-level, continuous noises, such as that generated by the increased vessel activity, are considered non-impulsive.

Southall *et al.* (2019) also presents single pulse, unweighted peak sound pressure level (SPL_{peak}) and cumulative weighted sound exposure level (SEL_{cum}) criteria for both onset of PTS and TTS (see Table 8.6). To account for the fact that different species groups use and hear sound differently, the thresholds in the weighted SEL_{cum} metric incorporate auditory weighting functions. As dual metrics, onset of PTS /TTS is considered to have occurred when either one of the two metrics is exceeded.

Table 8.6: Impulsive criteria for PTS and TTS in marine mammals (Southall *et al.,* 2019)

Functional Hearing Group	PTS criteria		TTS criteria	
	Unweighted SPLpeak	Weighted SELcum	Unweighted SPLpeak	Weighted SELcum
Low-frequency cetaceans	219 dB re 1 µPa	183 dB re 1 µPa^{2}s	213 dB re 1 µPa	168 dB re 1 µPa^{2}s
Mid-frequency cetaceans	230 dB re 1 µPa	185 dB re 1 µPa^{2}s	224 dB re 1 µPa	170 dB re 1 µPa^{2}s
High-frequency cetaceans	202 dB re 1 µPa	155 dB re 1 µPa^{2}s	196 dB re 1 µPa	140 dB re 1 µPa^{2}s
Pinnipeds in water	218 dB re 1 µPa	185 dB re 1 µPa^{2}s	212 dB re 1 µPa	170 dB re 1 µPa^{2}s

Where the SELcum metric is required, a fleeing animal model has been assumed for marine mammals. This assumes that a receptor, when exposed to high noise levels, will swim away from the noise source. For this, the following flee speeds have been used for each marine mammal group:

- 2.1 ms^{-1} for low-frequency cetaceans (LF) (SNH, 2016);
- 1.52 ms^{-1} for high-frequency cetaceans (HF) (Bailey and Thompson, 2006);
- 1.4 ms^{-1} for very high-frequency cetaceans (VHF) (SNH, 2016); and
- 1.8 ms^{-1} for phocid carnivores in water (PCW) (SNH, 2016).

These are highly conservative and considered worst case assumptions as marine mammals are expected to be able to swim much faster under stress conditions, especially at the start of piling when they would be closest to the pile and exposed to the highest noise levels.

Table 8.7 gives the predicted PTS and TTS maximum, mean and minimum impact ranges for marine mammals as a result of the underwater noise generated from the proposed pile driving operations, using the unweighted SPLpeak and weighted SELcum impulsive criteria from Southall et al. (2019).

Table 8.7: Summary of PTS and TTS ranges using the Southall et al. (2019) impulsive criteria for marine mammals (Subacoustech, 2021)

Southall et al. (2019) Unweighted SPLpeak criteria			Maximum Range (m)	Mean Range (m)	Minimum Range (m)
Unweighted SPLpeak					
PTS	LF	219 dB re 1 µPa	<50	<50	<50
	HF	230 dB re 1 µPa	<50	<50	<50
	VHF	202 dB re 1 µPa	<50	<50	<50
	PCW	218 dB re 1 µPa	<50	<50	<50
TTS	LF	213 dB re 1 µPa	<50	<50	<50
	HF	224 dB re 1 µPa	<50	<50	<50
	VHF	196 dB re 1 µPa	<50	<50	<50
	PCW	212 dB re 1 µPa	<50	<50	<50
Weighted SELcum criteria (fleeing)					
PTS	LF	183 dB re 1 µPa	<50	<50	<50
	HF	185 dB re 1 µPa	<50	<50	<50

Southall et al. (2019) Unweighted SPLpeak criteria			Maximum Range (m)	Mean Range (m)	Minimum Range (m)
	VHF	155 dB re 1 µPa	<50	<50	<50
	PCW	185 dB re 1 µPa	<50	<50	<50
TTS	LF	168 dB re 1 µPa	570	290	170
	HF	170 dB re 1 µPa	<50	<50	<50
	VHF	140 dB re 1 µPa	690	530	430
	PCW	170 dB re 1 µPa	<50	<50	<50

The unweighted SPLpeak results show that noise levels are unlikely to exceed the criteria beyond 50 m from the proposed piling operation. For the SELcum criteria, the PTS ranges are expected to stay below 50 m, with only TTS for LF and VHF cetaceans resulting in maximum ranges of 570 m and 690 m respectively.

To put the modelling results into context, Table 8.8 calculates the number of animals which may be exposed to PTS / TTS onset using the density and abundance estimates from the relevant MMMU within which the Victory field development is located. Note estimated density and abundance is only available for those species which are commonly observed in the Greater North Sea area. It can be seen from Table 8.8 that for all species it is predicted that less than one individual may be injured by the proposed piling operations or experience a temporary, recoverable reduction in hearing sensitivity. This number is small enough that there would be no effect at the population level, based on the percentage of the corresponding reference population potentially impacted.

Given the above, the sensitivity of marine mammals to physiological impacts has been evaluated as **Very High**; the receptor is of international importance (Very High value) and has limited tolerance / ability to adapt to the effect (Low to Medium resistance and resilience). As there is the potential for individuals to be permanently physically injured as a result of the proposed piling operations, albeit only a very small number, the magnitude of the impact has been assessed as **Major**, although it should be noted that the period during which individuals may encounter sound from the proposed operations is relatively short (piling operations may be ongoing for approximately one week but pile hammering will not be continuous throughout this period) and individuals are likely to move out of the area of impact once the proposed piling operations have commenced. Effects on marine mammals due to PTS / TTS onset as a result of the underwater noise emissions generated from the proposed piling operations are therefore predicted to be **Major** and significant prior to the implementation of operational mitigation measures. However, the possibility of PTS / TTS impacts occurring will be significantly reduced with the use of a 500 m mitigation zone, since piling operations will not commence until monitoring confirms that the area is clear of marine mammals (see Section 8.3). Residual effects on marine mammals are therefore reduced to **Minor** and would not be significant.

Table 8.8: Estimated Number of Animals Potentially Experiencing PTS / TTS from the Proposed Victory Piling Operations[1,2,3]

Species	Abundance	Estimated Density in Area (animals / km^2)	Southall et al. (2019) Unweighted SPLpeak criteria				Southall et al. (2019) Weighted SELcum criteria (fleeing)			
			PTS		TTS		PTS		TTS	
			Max number of animals impacted	Approx. % of reference population	Max number of animals impacted	Approx. % of reference population	Max number of animals impacted	Approx. % of reference population	Max number of animals impacted	Approx. % of reference population
Harbour porpoise	159,632	0.5	<1	0.0006	<1	0.0006	<1	0.0006	<1	0.0006
Bottlenose dolphin	1,885	0.003	<1	0.0530	<1	0.0530	<1	0.0530	<1	0.0530
Risso's dolphin	8,687	0.007	<1	0.0115	<1	0.0115	<1	0.0115	<1	0.0115
Common dolphin	57,417	0.06	<1	0.0017	<1	0.0017	<1	0.0017	<1	0.0017
Minke whale	10,288	0.01	<1	0.0097	<1	0.0097	<1	0.0097	<1	0.0097
White-beaked dolphin	34,025	0.02	<1	0.0029	<1	0.0029	<1	0.0029	<1	0.0029
White-sided dolphin	12,293	0.01	<1	0.0081	<1	0.0081	<1	0.0081	<1	0.0081
Grey seal[4]	5,100	0.2	<1	0.0196	<1	0.0196	<1	0.0196	<1	0.0196
Harbour seal[4]	3,039	0.04	<1	0.0329	<1	0.0329	<1	0.0329	<1	0.0329

[1] See Section 4.3.5 for MMMU abundance and population data; Table 4.19 for cetaceans and Table 4.20 for seals.
[2] Calculation method based on Southall *et al*. (2007) as recommended by JNCC (2010a).
[3] Max number of animals impacted has been rounded up to a whole number.
[4] Seal density data has been taken from Russel et al., 2017.

Behavioural Impacts

Marine mammals may also experience behavioural impacts in response to underwater noise emissions. Examples of behavioural responses include orientation or attraction to or from the noise source, increased alertness, modification of their own sound production characteristics, change in movement or diving behaviour, temporary change in habitat use and, in severe cases, panic, fleeing, or stranding behaviour, which may indirectly result in injury or death.

Southall *et al.* (2019) do not provide quantitative thresholds for disturbance to marine mammals from impulsive or non-impulsive noise sources. In English waters, a minimum Effective Deterrent Range (EDR) of 15 km has been proposed for assessing the significance of noise disturbance to harbour porpoise (VHF cetacean) from pin piling (JNCC *et al.*, 2020). This value is based on one study (Graham et al 2019) which found a 50% probability of harbour porpoise behavioural response within 7.4 km, in the 12 hours after the piling had ended (the deterrence distance during piling was not reported). The study also showed a 25% probability of response within approximately 18 km. Potential habituation was also recorded, with response distances decreasing over the duration of the piling operations. In the absence of agreed metrics for measuring marine mammal disturbance, an EDR of 15 km has been applied for all species in this assessment.

Using an EDR of 15 km, Table 8.9 calculates the number of animals which may experience some sort of behavioural impact using the density and abundance estimates from the relevant MMMU within which the proposed Victory field development is located.

Table 8.9: Estimated Number of Animals Potentially Experiencing Behavioural Impacts from the Proposed Victory Piling Operations[1,2]

Species	Abundance	Estimated Density in Area (animals / km^2)	Max number of animals impacted	Approx. % of reference population
Harbour porpoise	159,632	0.5	< 354	0.22
Bottlenose dolphin	1,885	0.003	< 3	0.0016
Risso's dolphin	8,687	0.007	< 5	0.058
Common dolphin	57,417	0.06	< 43	0.075
Minke whale	10,288	0.01	< 7	0.068
White-beaked dolphin	34,025	0.02	< 15	0.044
White-sided dolphin	12,293	0.01	< 8	0.065
Grey seal[3]	5,100	0.2	< 142	2.78
Harbour seal[3]	3,039	0.04	< 28	0.92

[1] See Section 4.3.5 for MMMU abundance and population data; Table 4.19 for cetaceans and Table 4.20 for seals.
[2] Calculation method based on Southall *et al*. (2007) as recommended by JNCC (2010a).
[3] Seal density data has been taken from Russel et al., 2017.

It can be seen from Table 8.9 that although the number of individual cetaceans which could temporarily exhibit some form of change in behaviour for the period in which they encounter sound from the proposed piling operations ranges from less than three for bottlenose dolphin to less than 354 for harbour porpoise, the percentage of the corresponding reference population impacted is comparatively low (less than 1%) for all species. In comparison, the number of individual grey seals which could temporarily exhibit some form of change in behaviour for the period in which they encounter sound from the proposed seismic survey operations is relatively high at less than 142 individuals, which is equivalent to approximately 3 % of the grey seal Shetland MU estimated population.

It should be noted, however, that the proposed piling operations will only be ongoing for approximately one week and pile hammering will not be continuous throughout this period. Temporarily affecting a small proportion of a population is highly unlikely to result in population level effects. In addition, behavioural changes such as moving away from an area for short periods of time, reduced surfacing time, masking of communication signals or echolocation clicks, vocalisation changes and separation of mothers from offspring for short periods, do not necessarily imply that detrimental effects will result for the animals involved (JNCC, 2010a).

Given the above, the sensitivity of marine mammals to behavioural impacts has been evaluated as **High**; the receptor is of international importance (Very High value) but is generally tolerant of behavioural effects and will immediately recover once operations cease (High resistance and resilience). The magnitude of impact is predicted to be **Minor** as the period during which marine mammals may encounter sound from the proposed operations is relatively short and individuals are likely to move out of the area of impact once the proposed operations have commenced. Any behavioural impacts will be short term and temporary and will cease once the piling operations have been completed and there will be no long-term reduction in the size of their available habitat, with individuals returning to the area on completion of the operations. Effects on marine mammals due to behavioural impacts as a result of the underwater noise emissions generated from the piling operations are therefore predicted to be **Minor** and are not considered to result in significant effects on the environment. However, operational measures will be implemented, as outlined in Section 8.3, to ensure behavioural impacts are minimised as much as possible.

There is also the possibility that the underwater noise emissions generated from both the proposed drilling activity and vessel operations may also cause some behavioural disturbance to marine mammals, particularly as the field development operations will be ongoing for a period of around five months. However, observations at installations in the North Sea have shown harbour porpoises regularly frequenting and actively foraging around platforms (Todd et al. 2009). In contrast, there is evidence that vessel traffic may influence marine mammals in several ways, reported responses include avoidance, changes in swimming and surfacing patterns, alteration of the intensity and frequency of calls and increases in stress-related hormones (Veirs et al. 2016, Rolland et al. 2012, Dyndo et al. 2015). Marine mammals West of Shetland are, however, accustomed to the presence of vessels in the area therefore any impacts to marine mammals as a result of underwater noise from vessel operations are assessed as **Negligible**.

8.2.5 European Protected Species (EPS) Risk Assessment

JNCC has produced good practice guidelines (JNCC, 2010a) and protocols for marine industries on how to assess the likelihood of committing an offence under The Conservation of Offshore Marine Habitats and Species Regulations 2017, how to avoid it and whether a licence to carry out activity might be required or not. It is considered that adherence to these guidelines constitutes best practice and will minimise the risk of committing an injury offence.

To reduce the risk of deliberate injury to any EPS, Corallian will ensure that the JNCC protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b) is followed.

A disturbance offence is more likely where an activity causes persistent (sustained and chronic) noise in an area for long periods of time. For most cetacean populations in the UK, disturbance in terms of the EPS is unlikely to result from single, short term operations such as the driving of small-diameter piles (JNCC, 2010a). The proposed Victory piling operations will be ongoing for approximately one week and pile hammering will not be continuous throughout this period. Although the activity may result in temporary sporadic disturbance to cetaceans, it is unlikely to impair the ability of an animal to survive or reproduce nor result in significant effects on the local abundance or distribution.

Given the above, it is considered unlikely that the proposed Victory field development activities would constitute an offence under The Conservation of Offshore Marine Habitats and Species Regulations 2017. However, in order to minimise the risk of disturbance to an EPS, mitigation measures have been proposed in Section 8.3.

8.3 Mitigation Measures

Impacts from underwater noise emissions generated during the proposed Victory development will be minimised by the implementation of the following mitigation measures:

- Optimise duration of drilling and installation activities in order to minimise vessel use.

- During the detailed design phase of the project, Corallian will review the possibility of using an alternative foundation design for the WHPS, PLEM / pigging skid and tie-in / protection structures in order to reduce the noise impact footprint.
- If piling is required, use the minimum diameter piles necessary to achieve structural integrity;
- The JNCC protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b) will be adhered to, including:
    - Use of properly qualified, trained and equipped marine mammal observers (MMOs) to detect marine mammals within a "mitigation zone" and potentially recommend a delay to piling operations. The mitigation zone will be at least 500 m. MMOs will carry out a 30 minute pre-piling survey and if an animal is detected then work should be delayed until it has left the area;
    - Soft-start of piling, whereby there is an incremental increase in power and, therefore, sound level. This should be carried out over a minimum period of 20 minutes. This is believed to allow any marine mammals to move away from the piling location and reduce the likelihood of exposing the animal to sounds which can cause injury;
    - Repeat of the pre-piling survey and soft-start whenever there is a break in piling of more than 10 minutes; and
    - Avoiding commencing piling at night or in poor visibility when marine mammals cannot reliably be detected.
- Where possible, piling operations will be timed to avoid periods of high sensitivity for marine mammals and fish.

8.4 Residual Effects

In summary, it is possible that short term behavioural effects may be observed among marine mammals and fish as a result of the underwater noise emissions generated from vessel use, drilling and piling activities during development of the Victory field, but any impacts will be mitigated by adherence to the mitigation measures detailed in Section 8.3 such that any residual effects are predicted to be Minor and not significant.

8.5 Transboundary Impacts

The Victory field development area is located 95 km away from the UK/Faroe median line at its closest point. Given the distance, underwater noise emissions generated from the proposed development operations are unlikely to be detected into international waters and therefore no significant transboundary impacts are predicted.

8.6 Cumulative Impacts

As marine mammals may exhibit significant behavioural changes out to a distance of 15 km from the Victory field during the proposed piling operations, it is possible that marine mammals could experience cumulative effects if impulsive noise was generated from other anthropogenic sources (e.g. other West of Shetland oil and gas development activity) at the same time. However, given the short duration and the temporary nature of the proposed piling activity and the mitigation measures that will be in place, significant cumulative impacts are not expected.

9 Atmospheric Emissions

9.1 Introduction

This section assesses the potentially significant impacts on the climate and air quality, which could arise from atmospheric emissions generated during the development of the Victory field as a result of:

- Power generation on the drilling rig, vessels and helicopters during the proposed Victory drilling operations;
- Flaring of hydrocarbons during the well flow test to be undertaken prior to production;
- Power generation on vessels during installation, hook-up and commissioning of the Victory subsea infrastructure, namely the pipeline, umbilical, wellhead, xmas tree, PLEM / pigging skid and tie-in / protection structures and associated tie-in arrangements.

Note, well testing for Victory is unavoidable as it is required to clean out the wellbore, recover representative / uncontained samples of the reservoir fluid and confirm reservoir deliverability. Currently the only analysis of Victory gas comes from a single flowline sample taken during a drill stem test on well 207/01- 3 in 1977. The well test will also confirm that the gravel pack completion is effective in controlling sand production. If the well is not cleaned-up, gas would be contaminated with drilling / completion fluid and would likely not meet entry-specification for the GLA system.

During the production phase, gas from the Victory field will be processed at the SGP with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the development (see Section 2.3.2). However, as the SGP is located onshore, the emissions arising at SGP as result of the Victory development are outside of the scope of this ES. Offshore, the robust design of the Victory well, which allows for an open hole gravel pack completion for sand control, permanent downhole pressure gauge and flow meter, should avoid the need for well intervention throughout the life of the Victory, thereby preventing the production of further GHG emissions during the production phase.

9.2 Background

9.2.1 GHG Emissions Reduction Targets

The Climate Change Act 2008 (as amended) commits the UK government by law to reducing GHG emissions by at least 100% of 1990 levels (net zero) by 2050. Scotland has committed to becoming a Net Zero society by 2045, five years ahead of the rest of the UK, with interim targets of 75% by 2030 and 90% by 2040.

The NSTA is fully committed to enabling the achievement of the UK government's commitment to reach Net Zero emissions by 2050. The revised OGA Strategy (2020a), which amends the MER UK Strategy, came into force on 11 February 2021 and requires industry to operate in a way consistent with Net Zero ambitions, lowering production emissions and making serious progress on the solutions that can contribute to the UK achieving net zero.

The North Sea Transition Deal (BEIS, 2021a), announced in March 2021, recognises that the oil and gas industry will have a critical role in maintaining the UK's energy security through the transition to net zero carbon by 2050. Domestically produced gas still met approximately 46% of the country’s supply of gas in 2019 and the Climate Change Committee forecasts our continued need for fossil fuels for years to come.

The Deal sets out an ambitious plan for how the UK’s offshore oil and gas sector and the government will work together to deliver the skills, innovation and new infrastructure required to meet the stretching GHG emissions reduction targets, including:

- Reduction of emissions from oil and gas production by 10% by 2025, by 25% by 2027 and by 50% by 2030 (all relative to 2018 baseline), as measurable steps to a net zero basin by 2050; and

- Implementation of the NSTA (previously OGA) Net-Zero Asset Stewardship Expectation (OGA, 2021a), to encourage emissions reductions from both existing and new developments.

Further information on how the concept selection process for the proposed Victory development has considered these targets, along with other relevant requirements relating to the oil and gas industry as set out in key UK strategy and policy documents on the transition to Net Zero, is provided in Section 2.3.1.

Of note is that the majority of GHG emissions arising from the development of the Victory field will be as a result of vessel usage. In 2018, the International Maritime Organization (IMO) adopted an initial strategy on the reduction of GHG emissions from ships, setting out a vision which confirms IMO's commitment to reducing GHG emissions from international shipping and to phasing them out as soon as possible (IMO, 2018). The initial GHG strategy envisages, in particular, a reduction in carbon intensity of international shipping (to reduce CO_2 emissions per transport work, as an average across international shipping, by at least 40% by 2030, pursuing efforts towards 70% by 2050, compared to 2008); and that total annual GHG emissions from international shipping should be reduced by at least 50% by 2050 compared to 2008.

9.2.2 Industry Progress to Date

The Energy Transition Outlook Report (OEUK, 2021a) sees the oil and gas industry's first progress update following the launch of emissions reduction targets in 2020, namely reductions of 50% by 2030 and 90% by 2040, accounting for all GHG emissions from all upstream oil and gas operations (compared with a 2018 baseline, including reductions from the decommissioning of assets). The report shows that industry has seen a 10% emissions reduction from the 2018 baseline, falling from 18.883 Mt CO_2e to 17.06 Mt CO_2e in 2020. Direct emissions from the UK oil and gas sector are being driven down with a 2 million tonne cut in emissions during 2020, of which OEUK estimates that around half can be attributed to operators' actions. While production in 2020 fell 5%, predominantly due to the impacts of COVID-19 on production and activity, emissions fell by 10% (OEUK, 2021a). For the UK as a whole, in 2022, net territorial GHG emissions were estimated to be 405.5 Mt CO_2e, a decrease of 9.5% compared to the 2019 figure of 447.9 Mt CO_2e. CO_2 made up around 79% of the 2020 total (BEIS, 2022).

The oil and gas industry also aims to halve methane (CH_4) emissions by 2030 (against a 2018 baseline) in accordance with overall emission reduction targets. In 2019, total CH_4 emissions from the upstream oil and gas sector in the UK including emissions at onshore terminals was 42,000 tonnes. CH_4 emissions from the upstream sector have more than halved since 1990, primarily from reductions in flaring and particularly venting activity. They have remained stable from 2013 to 2018, during which time production has increased by 20%, resulting in a sustained decline in CH_4 intensity (CH_4 emissions per unit of production) over the same timeframe (OEUK, 2021b).

9.3 Assessment of Impacts

The potential environmental effects from gaseous emissions generated from the Victory development can be broadly summarised as follows:

- **Climate change:** anthropogenic sources of GHG emissions (particularly CO_2, but also CH_4 and NOx) are implicated in amplifying the natural greenhouse effect resulting in climate change. The potential effects of emissions of GHG are therefore global in scale; however, emissions from offshore oil and gas production only form a small proportion of the UK's total GHG emissions (just over 4% in 2020) (OEUK, 2021a, BEIS 2021b).
- **Air quality:** inputs of contaminants such as NOx and VOCs can contribute to the formation of local tropospheric ozone and photochemical smog, resulting in a reduction in local air quality, which in turn can result in effects on human health.

9.3.1 Climate Change

In order to put the CO_2 emissions generated from Victory in context, Table 9.1 summarises the worst-case amount of CO_2 that could be generated during the development of the field, in comparison with the total annual CO_2 emissions generated offshore from the UKCS in 2020; estimated at 15 Mt CO_2, which in turn is around 4.6% of the total CO_2 emissions produced from all sectors in the UK in 2020, estimated at 324 Mt CO_2 (OEUK, 2021b, BEIS, 2022).

Table 9.1: Estimated Worst-Case CO_2 Emissions Generated during the Development of the Victory Field

Aspect	CO_2 Emissions Emitted from the Victory Development (tonnes) [1]	Percentage of Offshore UKCS Annual Total CO_2 [2]	Percentage of UK Annual Total CO_2 [3]
Fuel use by drilling rig, support vessels and helicopters [4]	5,515	0.04%	0.0017%
Well flow test (flaring) [5]	3,920	0.03%	0.0012%
Fuel use by vessels during installation, hook-up and commissioning [6]	13,866	0.09%	0.0043%
Totals:	**23,301**	**0.16%**	**0.0072%**

[1] Emission factors from DECC (2008).
[2] Annual Total Offshore UKCS CO_2 emissions were estimated at 15.01 million tonnes. This is calculated based on the estimation that 88% of UKCS GHG emissions are CO_2 (OGA, 2021c) with the UKCS CO_2e emissions recorded at 17.06 Mt CO_2e in 2020 (OEUK, 2021a).
[3] Annual Total UK CO_2 emissions were estimated at 324.4 million tonnes. This is calculated based on the estimation that 80% of UK total GHG emissions are CO_2 (OGA, 2021c) with the UK CO_2e emissions recorded at 405.5 million tonnes in 2020 (BEIS, 2022).
[4] See Table 3.5 (Section 3.3.7) – Based on 1,724 tonnes of fuel used
[5] See Table 3.5 (Section 3.3.7) - Assumes a total of 1,400 tonnes of equivalent hydrocarbon may be flared over three flow periods, each up to six hours in duration. Victory gas composed of approximately 98% of CH_4 (Corallian, 2022).
[6] See Table 3.10 (Section 3.4.8) – Based on 4,333 tonnes of diesel used

It can be seen from Table 9.1 that the predicted emissions associated with the proposed Victory drilling operations, well flow test, installation and hook-up and commissioning activities would represent a very small percentage of the total annual CO_2 emissions on the UKCS, equivalent of 0.16% of the offshore UKCS annual total and 0.0072% of the UK annual total. Nevertheless, it is recognised that the residence time of GHG emissions in the atmosphere gives rise to the climate change impact.

In order to minimise GHG emissions during the proposed field development, Corallian therefore proposes to adopt the following measures for Victory:

- Vessel mobilisation and demobilisation distances will be reduced, as far as practical;
- Where possible, activities will be scheduled to minimise waiting on weather;
- Opportunities to share supply boats with nearby operators will be explored to minimise vessel trips;
- Supplier's environmental footprints will be factored into the tender evaluation process.

The well flow test will be designed not only to achieve its goals, but to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will also be utilised to ensure all hydrocarbons are burnt completely.

Global Warming Potential (GWP) represents how much a given mass of a chemical contributes to climate change over a given time period compared to the same mass of CO_2. The GWP of CO_2 is defined as 1.0. For example, the 100-year GWP of CH_4 is 25, which means that if the same mass of CH_4 and CO_2 were introduced into the atmosphere, CH_4 will trap 25 times more heat than CO_2 over the next 100 years (IPCC, 2007). Table 9.2 calculates the equivalent mass of CO_2 required to achieve the same GWP as the total predicted emissions of N_2O and CH_4 generated during the development of the Victory field.

Table 9.2: The Global Warming Potential (GWP) for the Atmospheric Emissions Associated with the development of the Victory Field

Gas	Total Predicted Emissions (tonnes)	GWP[1] Factor	Equivalent Mass of CO_2 to Achieve the Same GWP (tonnes)
Drilling, Well Flow Test, Installation, Hook-Up and Commissioning (Total Emissions)			
CO_2	23,301	1	23,301
N_2O	1.5	298	447
CH_4	64.1	25	1,602
		Total	**25,350**

[1] Emissions are converted into CO_2-equivalents based on 100-year GWP (GWP_{100}), in the IPCC Fourth Assessment Report (IPCC, 2007). Please note GWPs are only available for CO_2, N_2O and CH_4

This shows that the worst-case predicted annual emissions of CO_2, N_2O and CH_4 from power generation and flaring activities have a combined GWP equivalent to 25,350 tonnes of CO_2e which is equal to 0.15% of the total tonnes of CO_2e GHG emissions generated offshore from the UKCS in 2020 (17.06 million tonnes; OEUK, 2021a), or 0.0063 % of the total tonnes of CO_2e GHG emissions generated in the UK from all sectors during 2020 (405.5 million tonnes; BEIS, 2022).

As noted in Section 2.3.1, The Climate Change Act 2008 (as amended) requires the government to set legally-binding 'carbon budgets' to act as stepping stones towards the 2050 target. These carbon budgets restrict the total amount of GHG that the UK can emit over five-year periods, ensuring continued progress towards the UK's long-term climate target. Table 9.3 lists the six carbon budgets which have been put into law to date and run up to 2037 and confirms whether the UK is on track to meet these climate targets.

Table 9.3: UK Carbon Budget[1]

Carbon Budget	Carbon Budget Level	Reduction Below 1990 Levels	Met?
1st carbon budget (2008 to 2012)	3,018 $MtCO_2e$	25%	Yes
2nd carbon budget (2013 to 2017)	2,782 $MtCO_2e$	31%	Yes
3rd carbon budget (2018 to 2022)	2,544 $MtCO_2e$	37% by 2020	On track
4th carbon budget (2023 to 2027)	1,950 $MtCO_2e$	51% by 2025	Off track
5th carbon budget (2028 to 2032)	1,725 $MtCO_2e$	57% by 2030	Off track
6th carbon budget (2033 to 2037)	965 $MtCO_2e$	78% by 2035	Off track

[1] Values from HM Government (2021)

Development activities at the Victory field are currently scheduled to occur in 2024, during the CB4 period, with production operations occurring over an eight year period from 2024 to 2031, during both CB4 and CB5. Decommissioning activities may take place during either CB5 or CB6. It can be seen from Table 9.3 that the UK is currently off track to meet their carbon budget targets during this period.

Table 9.4 presents the worst-case predicted routine CO2e emissions for Victory against the relevant UK carbon budget. As previously noted, all atmospheric emissions associated with the production phase of Victory are generated onshore at the SGP and are considered to be outside of the scope of the ES. As a worst case, it is assumed that decommissioning activities are undertaken during CB6 as this has a lower carbon budget than CB5.

Table 9.4: Victory Development Routine CO_2e Emissions Against the UK Carbon Budget

Emission Item	Carbon Accounting Period		
	CB4 (2023 to 2027)	CB5 (2028 to 2032)	CB6 (2033 to 2037)
UK carbon budget for period (tonnes of CO_2e)[1]	1,950,000,000	1,765,000,000	965,000,000
Victory Development offshore emissions for the period (tonnes of CO_2e)	25,350[2]	0[2]	3,747[3]
Percentage of UK Budget CO_2e emitted by Victory Development	0.0013%	0%[2]	0.0004%

[1] Values from HM Government (2021)

[2] Value associated with drilling, well flow test, installation, hook-up and commissioning activities.

[3] Based on 1,146 tonnes of fuel used for decommissioning activities (see Section 3.6).

It can be seen from Table 9.4, that CO_2e emissions generated during the development of the Victory, contribute only a very small amount to CB4, equal to less than 0.0013% of the UK budget. It can also be seen that, if carried out during CB6, the CO_2e emissions generated during the decommissioning activities would be less than 0.0004% of the carbon budget for this period.

It should be borne in mind that the emissions estimated for Victory are worst-case values for the purpose of planning and actual annual emissions are likely to be lower. Furthermore, although the Victory asset is being designed primarily for production of Victory gas, scoping studies performed under the CCS Appraisal Project suggest that Victory facilities may be suitable for re-use for CCS after cessation of production (see Section 2.3.4 for further details). The proposed Victory development well has therefore been designed so it is potentially suitable for future re-use as a CO_2 injection well and the design of the Victory production pipeline will also be suitable to transport dry CO_2. Repurposing the Victory to CCS would result in the removal of CO_2, which would help towards the UK meeting its carbon budget targets in the future.

In summary, the atmospheric emissions from the proposed Victory development activities will contribute to the global emissions of GHG, namely CO_2, N_2O and CH_4. The sensitivity of the receptor (i.e. the climate) is **Very High** (the resistance is medium, particularly as the UK is off track to meet their future carbon budget targets and the value is very high). However, the emissions generated will form a very small percentage of the total tonnes of CO_2e GHG emissions from all sectors in the UK (i.e. 0.0063%) and contribute only a small fraction towards future carbon budgets, with estimated Victory CO_2e emissions produced during the development phase equal to less than 0.0013% of the CB4 target. As discussed in Section 2.3.2, development of the Victory gas field will contribute to the security of the UK's gas supply during the UK's transition to renewable energy, decreasing the reliance on imported gas which potentially has a much higher EI. The impact is therefore considered to be **Minor**. Any effects on the climate will therefore be **Moderate**, but not significant provided the mitigation measures proposed in Section 9.4 are implemented.

9.3.2 Air Quality

The emissions generated by the combustion of hydrocarbons for power generation during the Victory Development could potentially have a negative impact on local air quality.

Atmospheric pollutants such as NOx, VOCs and particulates can contribute to the formation of low level ozone and photochemical smog. However, the open and dynamic metocean environment in the West of Shetland region should help disperse emissions quickly and prevent accumulations which could result in a reduction of local air quality.

Given the offshore location of the Victory field, it is anticipated that the atmospheric emissions generated during the proposed development operations will disperse rapidly under most conditions to levels approaching background within a few tens of metres of their source. As such, although there could be a short term deterioration in local air quality, the magnitude of impact is considered to be **Negligible** and regardless of receptor sensitivity no adverse significant effects are predicted.

9.4 Mitigation Measures

Impacts on climate and air quality from power generation on MODU, vessels and helicopters during drilling, installation hook-up and commissioning activities and flaring of hydrocarbons during the well flow test will be minimised by the implementation of the following mitigation measures:

- Vessel mobilisation and demobilisation distances will be reduced, as far as practical;
- Where possible, activities will be scheduled to minimise waiting on weather;
- Opportunities to share supply boats with nearby operators will be explored to minimise vessel trips;
- Supplier's environmental footprints will be factored into the tender evaluation process;
- Vessels will be operated, where possible, in modes that allow for economical fuel use;
- Combustion equipment on the MODU shall be appropriately maintained to ensure emissions are minimised, as far as practicable.
- The well test and well clean-up activities will be designed not only to achieve their goals but to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely.
- Procedures will be in place in order to reduce flaring at the SGP during maintenance operations, process upset conditions, system depressurisation and start-up.

9.5 Residual Effects

Residual effects on air quality are predicted to be Negligible as emissions will rapidly disperse given the offshore location of the proposed Victory development. In addition, provided that the mitigation measures detailed in Section 9.4 are implemented, no significant adverse residual effects on the climate are predicted as a result of the Victory Development. GHG emissions associated with the Victory Development represent only a small proportion of GHG emissions typically arising from oil and gas developments in the UKCS and will only contribute a small fraction of CO_2e emissions towards future UK carbon budget targets. Production from Victory also represents significantly lower than average emissions per tonne of oil equivalent produced compared with other gas fields on the UKCS or imported sources (refer to Section 2.3.2). All gas produced from the Victory field will flow to the SGP and will be used domestically and not exported. In summary, development of the Victory gas field provides the UK with a comparatively low carbon indigenous gas source during the transition to renewable energy, helping contribute to energy security and assist in the delivery of Net Zero UK carbon emissions by 2050.

9.6 Transboundary Impacts

The UK/Faroe Islands median line is located approximately 110 km to the north west of the proposed Victory field. Given the offshore location of the Victory field, atmospheric emissions generated during the proposed development operations will disperse rapidly under most conditions to levels approaching background within a few tens of metres of their source and therefore significant impacts on air quality in the Faroe Islands waters are not predicted.

It is recognised that climate change is a global issue; however, GHG emissions associated with the Victory Development represent only a small proportion of GHG emissions typically arising from oil and gas developments in the UKCS. As described in Section 9.3.1, the effects on climate will not be significant provided that the mitigation measures detailed in Section 9.4 are implemented.

9.7 Cumulative Impacts

The closest surface oil and gas infrastructure to the proposed Victory development is the Clair Ridge platform located approximately 41 km south west of the proposed Victory well, followed by the Clair platform located approximately 45 km south west of the proposed Victory well (refer to Section 4.4.3).

Corallian is also aware that Equinor's proposed West of Shetland Rosebank field development is scheduled for a key financial investment decision in 2022. If a decision is made to proceed with the development there is a possibility that field development activities for Rosebank could be ongoing at the same time as Victory. Rosebank is located approximately 130 km north west of the Shetland Islands. The gas pipeline will run in a south-east direction from the Rosebank field for approximately 236 kilometres, before tying into the SIRGE pipeline in the northern North Sea. This route lies to the south of BP's Clair field and is therefore some distance from the proposed Victory field.

Given the distance separating Victory from the existing surface oil and gas infrastructures and the proposed Rosebank development, it is unlikely that there will be any cumulative impacts from atmospheric emissions on air quality over this period. In addition, it should be noted that the drilling, installation and hook-up commissioning activities are temporary events. During routine production, no further atmospheric emissions released offshore. Any cumulative impacts on air quality are therefore not considered to be significant.

Due to the residence time of GHG emissions in the atmosphere, it is recognised that development of the Victory field will contribute to climate change impacts in combination with the other projects and activities emitting GHG emissions. However, as noted above, the emissions generated from the proposed Victory development will form a very small percentage of the total tonnes of CO_2e from all sectors in the UK (i.e. 0.0063%) and will contribute only a small fraction towards future carbon budgets. The chosen field development concept option has the lowest emissions of GHG relative to the alternative concepts and during the development of the field, Corallian will seek to minimise GHG emissions by reducing vessel days and fuel consumption. The well test and well clean-up activities will be designed not only to achieve their goals but to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Furthermore, after cessation of production at Victory, the field has the potential to be re-purposed for CCS. As such, In summary, development of the Victory field will provide a low carbon, indigenous gas source, during the transition to renewable energy, helping contribute to energy security and assist in the delivery of Net Zero UK carbon emissions by 2050.

10 Marine Discharges

10.1 Introduction

Corallian is committed to minimising discharges into the marine environment from its operations, as far as possible. This section assesses the potentially significant impacts on water quality, plankton and fish that may arise from the following planned operational discharges associated with the proposed Victory development:

- Discharge of drill cuttings and muds;
- Discharge of residual hydrocarbons when drilling through the payzone;
- Discharge of chemicals during drilling, installation and hook-up and commissioning activities;
- Discharge of completion brine during well clean-up activities.

10.2 Assessment of Impacts

10.2.1 Discharge of Drill Cuttings and Muds

As described in Section 3.3.5, the proposed Victory well will be drilled riserless with seawater and bentonite sweeps for the two top hole sections (36 and 17½ inch). Cuttings from these top-hole sections will be discharged directly from the wellbore at the seabed. The remaining well sections will be drilled with a riser using WBM and cuttings will be returned to the rig and passed through the shale shaker systems where they will be separated from the drilling mud and passed through the cuttings cleaning system. The drill cuttings will then be discharged to sea from the drilling rig just below the sea surface. Note that the discharge of drill cuttings, muds and cement to the seabed has been assessed in detail in Section 7.

In terms of potential impacts in the water column, the discharge of WBM and cuttings from the drilling rig's shale shaker system will result in a temporary effluent plume descending through the water column containing dill cuttings with a thin coating of residual WBM. This plume of material will be carried away rapidly from the drilling rig and the dissolved constituents, consisting of non-toxic and biodegradable chemicals, will be quickly diluted. Cuttings from salt formations will dissolve and cuttings of clay and shale will start to disintegrate in the seawater before being deposited on the seabed. In energetic offshore environments such as the proposed Victory development location, drilling muds and cuttings are typically diluted 100-fold within 10 m of the discharge and 1,000-fold after a transport time of circa. 10 minutes at a distance of approximately 100 m from the rig. This rapid dilution of the WBM and cuttings plume in the water column suggests that harm to the flora and fauna in the water column is unlikely, and has never been demonstrated (Neff, 2005).

Water Quality

The sensitivity of water column to contamination from the planned discharge of drill cuttings and WBM is considered to be **Low**. The receptor has a low value; as only the water column in close proximity to the discharge point will be impacted, hence it is considered to be of local importance. The West of Shetland area is characterised by persistent, long-period swells, complex current regimes and rapidly changing weather conditions. The water quality is subject to rapid refreshment rates and mixing of the water column, coupled with strong wave action on the sea surface. Therefore, the receptor resistance and resilience is very high to drill cutting and WBM discharges. The magnitude of impact is considered to be **Minor**, with a short-term temporary change in baseline environmental conditions. Effects on water quality due to the discharge of drill cuttings and WBM are therefore assessed as **Minor**.

Plankton

The sensitivity of plankton to the planned discharge of drill cuttings and WBM is considered to be **Low**. The receptor is of medium value; the plankton community has a regional importance to the Faroe-Shetland Channel, providing a food source to higher trophic levels in this region. However, the temporary effluent plume made from drill cuttings and WBM is expected to disperse rapidly and the plankton has high recoverability in the short-term with high reproduction rates. Therefore, the receptor resistance and resilience is very high to drill cutting and WBM discharges. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the WBM and cuttings plume in the water column is anticipated. Any changes to the plankton community are anticipated to be immeasurable / undetectable. Effects on plankton due to the discharge of drill cuttings and WBM are therefore assessed as **Negligible**.

Fish

The sensitivity of fish to the planned discharge of drill cuttings and WBM is considered to be **Low**. The receptor has a high value; the fish community in the vicinity of the Victory location is of commercial importance on a national level. However, the temporary effluent plume made from drill cuttings and WBM is expected to disperse rapidly and fish have the ability to avoid the impacted area. Therefore, the receptor resistance and resilience is very high to drill cutting and WBM discharges. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the WBM and cuttings plume in the water column is anticipated. Any changes to the fish community are anticipated to be immeasurable / undetectable. Effects on fish due to the discharge of drill cuttings and WBM are therefore assessed as **Negligible**.

10.2.2 Discharge of Residual Hydrocarbons when Drilling through the Payzone

As described in Section 3.3.5, as a worst case it is estimated that the 8½ inch section of the well will penetrate the reservoir over a length of 110 m, generating approximately 11 tonnes of cuttings, which could be contaminated with a total of 100 kg of hydrocarbons discharged from the rig. Any hydrocarbons discharged to sea are anticipated to dilute rapidly with the turbidity of the water and broken down through biodegradation processes. It is therefore expected that any impact to the marine environment as a result of the residual reservoir hydrocarbon discharge will be highly localised. Additionally, a produced water study undertaken for the Norwegian petroleum sector stated that whilst effects could be detected in individual organisms, no effects were found on the population or community scale (OGUK, 2014). During the proposed drilling operations, a minimum of five samples will be taken from the shakers (at the point of discharge) and will be sent to a laboratory for analysis to ground truth the estimated amounts of reservoir hydrocarbons discharged. Corallian will seek permission to discharge the potentially contaminated drill cuttings and muds via the submission of an Oil Discharge Permit SAT on the UK Energy Portal, as required under The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended).

Water Quality

The sensitivity of water column to contamination from the planned discharge of residual reservoir hydrocarbon from pay zone drill cuttings is considered to be **Low**. The receptor has a low value; as only the water column in close proximity to the discharge point will be impacted, hence it is considered to be of local importance. The West of Shetland area is characterised by persistent, long-period swells, complex current regimes and rapidly changing weather conditions. The water quality is subject to rapid refreshment rates and mixing of the water column, coupled with strong wave action on the sea surface. Therefore, the receptor resistance and resilience is very high to residual reservoir hydrocarbon from pay zone drill cutting discharges. The magnitude of impact is considered to be **Minor**, with a short-term temporary change in baseline environmental conditions. Effects on water quality due to the discharge of residual reservoir hydrocarbon from pay zone drill cuttings are therefore assessed as **Minor**.

Plankton

The sensitivity of plankton to the planned discharge of residual reservoir hydrocarbon from pay zone drill cuttings is considered to be **Low**. The receptor is of medium value; the plankton community has a regional importance to the Faroe-Shetland Channel, providing a food source to higher trophic levels in this region. However, the residual reservoir hydrocarbons are not expected to persist within the marine environment and the plankton has high recoverability in the short-term with high reproduction rates. Therefore, the receptor resistance and resilience is very high to residual reservoir hydrocarbons from the pay zone drill cutting discharges. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the residual reservoir hydrocarbons in the water column are anticipated. Any changes to the plankton community are anticipated to be immeasurable / undetectable. Effects on plankton due to the residual reservoir hydrocarbon from pay zone drill cuttings are therefore assessed as **Negligible**.

Fish

The sensitivity of fish to the planned discharge of residual reservoir hydrocarbon from pay zone drill cuttings is considered to be **Low**. The receptor has a high value; the fish community in the vicinity of the Victory location is of commercial importance on a national level. However, the residual reservoir hydrocarbons are not expected to persist within the marine environment and fish do have some tolerance / ability to avoid, adapt and recover from hydrocarbon pollution. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the residual reservoir hydrocarbons in the water column are anticipated. Any changes to the fish community are anticipated to be immeasurable / undetectable. Effects on fish due to the residual reservoir hydrocarbon from pay zone drill cuttings are therefore assessed as **Negligible**.

10.2.3 Discharge of Drilling and Pipeline Commissioning Chemicals

During the proposed Victory drilling and pipeline commissioning operations there will be routine discharges of commissioning, completion and rig chemicals (refer to Section 3).

These chemicals have the potential to result in a significant impact on the marine environment. Chemical discharges to the marine environment can result in wide ranging environmental impacts, including a decline in water quality, changes in water chemistry (such as pH and temperature), toxicity effects from chemical components and the contamination of seabed sediments as well as acute or long term effects on marine organisms. Whether these effects are realised depends on a number of factors such as the inherent toxicity of the material, the quantities discharged and resulting concentrations in the water column, the length of time biota are exposed to that concentration and the sensitivity of the organisms to the particular chemical (OGUK, 2019).

In accordance with the Offshore Chemical Regulations 2002 (as amended), Corallian considers the minimisation of chemical usage a priority and recognises that substitution is an important aspect of the OSPAR Harmonised Mandatory Control Scheme (HMCS). The majority of products which will be used during the proposed drilling and pipeline commissioning operations are relatively environmentally benign and a large number are also considered to pose little or no risk (PLONOR) to the marine environment. However, it will be necessary to use chemicals such as biocides, fluid loss control agents, corrosion inhibitor and tracer dye which due to their nature can carry substitution warnings. Corallian is committed to the investigation of alternative components and products and, where practicable, chemicals with a high risk profile will be substituted out in favour of those with an improved environmental profile. In addition, prior to operations commencing, Corallian will undertake a site-specific risk assessment of the chemicals to be used and discharged during the proposed Victory drilling and pipeline commissioning operations, which will be detailed within the appropriate Chemical Permit SAT. This will ensure that there is no significant risk to the marine environment upon discharge.

It is anticipated that once discharged, the chemicals used will rapidly disperse given the hydrographic regime in the area and will be readily broken down through natural biodegradation processes.

Water Quality

The sensitivity of water column to contamination from the planned, routine discharge of chemicals is considered to be **Low**. The receptor has a low value; as only the water column in close proximity to the discharge point will be impacted, hence it is considered to be of local importance. The West of Shetland area is characterised by persistent, long-period swells, complex current regimes and rapidly changing weather conditions. The water quality is subject to rapid refreshment rates and mixing of the water column, coupled with strong wave action on the sea surface. Therefore, the receptor resistance and resilience is very high to planned, routine chemical discharges. The magnitude of impact is considered to be **Minor**, with a short-term temporary change in baseline environmental conditions. Effects on water quality due to planned, routine chemical discharges are therefore assessed as **Minor**.

Plankton

The sensitivity of plankton to the planned, routine discharge of chemicals is considered to be **Low**. The receptor is of medium value; the plankton community has a regional importance to the Faroe-Shetland Channel, providing a food source to higher trophic levels in this region. However, the planned, routine discharge of chemicals is not expected to persist within the marine environment and the plankton has high recoverability in the short-term with high reproduction rates. Therefore, the receptor resistance and resilience is very high to planned, routine discharge of chemicals. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the chemicals in the water column are anticipated. Any changes to the plankton community are anticipated to be immeasurable / undetectable. Effects on plankton due to the routine discharge of chemicals are therefore assessed as **Negligible**.

Fish

The sensitivity of fish to the planned, routine discharge of chemicals is considered to be **Low**. The receptor has a high value; the fish community in the vicinity of the Victory location is of commercial importance on a national level. However, the planned, routine discharge of chemicals is not expected to persist within the marine environment. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the planned, routine discharge of chemicals in the water column is anticipated. Any changes to the fish community are anticipated to be immeasurable / undetectable. Effects on fish due to the planned, routine discharge of chemicals are therefore assessed as **Negligible**.

10.2.4 Discharge of Fluids during Well Clean-up and Testing Activities

As described in Section 3.3.6, prior to production commencing, the well will be cleaned up to remove any drilling fluids waste and debris remaining in the well to prevent damage to the pipeline. Initially the wellbore will be cleaned-up with the in-situ drilling mud, then changed out to calcium chloride brine, the lower completion run, the lower completion gravel pack completed, then a further clean-up above the lower completion completed using the in-situ brine, before finally running the upper completion. Both drilling mud and completion brine will be stored in tanks/pits prior to being run into the well. During this process, approximately 800 bbls (127 m^3) completion brine will be used and discharged.

Following clean-up, a main well flow test will be undertaken via the rig to obtain reservoir information and fluid samples. No chemicals will be needed to flow the well, but if the well does not flow naturally, nitrogen would be on standby to initiate flow artificially. There are currently envisaged to be three, six-hour flow periods during the well test. The amount of brine remaining in the tubing at the start of the well test programme is calculated to be ca. 178 bbls (28 m^3), which is included in the total 800 bbls to be filtered / discharged as noted above. The maximum amount of formation water expected to be produced during the well flow test, is 50 bbls (8 m^3). This would be separated from the gas, along with the brine during the first flow period.

All returned completion and well test fluids will be pumped to a filter unit on the rig prior to being discharged overboard. The retuned fluids have the potential to be contaminated with residual reservoir hydrocarbons and will only be discharged once the oil in water concentration is equal or below 30 mg/l after passing through a water treatment filtration package. In a worst case scenario, therefore, a total of around 4 kg of hydrocarbons might be discharged.

Any hydrocarbons discharged to sea are anticipated to dilute rapidly with the turbidity of the water and broken down through biodegradation processes. It is therefore expected that any impact to the marine environment as a result of the residual reservoir hydrocarbon discharge will be highly localised. Additionally, a produced water study undertaken for the Norwegian petroleum sector stated that whilst effects could be detected in individual organisms, no effects were found on the population or community scale (OGUK, 2014). During the proposed well clean-up and testing operations, representative oil in water samples will be taken (at the point of discharge) and will be sent to a laboratory for analysis to ground truth the estimated amounts of reservoir hydrocarbons discharged. Corallian will seek permission to discharge the potentially contaminated well clean-up and test fluids via the submission of an Oil Discharge Permit SAT on the UK energy portal, as required under The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended).

Water Quality

The sensitivity of the water column to contamination from the planned discharge of residual reservoir hydrocarbons from well clean-up and testing operations is considered to be **Low**. The receptor has a low value; as only the water column in close proximity to the discharge point will be impacted, hence it is considered to be of local importance. The West of Shetland area is characterised by persistent, long-period swells, complex current regimes and rapidly changing weather conditions. The water quality is subject to rapid refreshment rates and mixing of the water column, coupled with strong wave action on the sea surface. Therefore, the receptor resistance and resilience is very high to reservoir hydrocarbon discharges from well clean-up and testing operations. The magnitude of impact is considered to be **Minor**, with a short-term temporary change in baseline environmental conditions. Effects on water quality due to the discharge of residual reservoir hydrocarbon from well clean-up and testing are therefore assessed as **Minor**.

Plankton

The sensitivity of plankton to the planned discharge of residual reservoir hydrocarbons from well clean-up and testing operations is considered to be **Low**. The receptor is of medium value; the plankton community has a regional importance to the Faroe-Shetland Channel, providing a food source to higher trophic levels in this region. However, the residual reservoir hydrocarbons are not expected to persist within the marine environment and the plankton has high recoverability in the short-term with high reproduction rates. Therefore, the receptor resistance and resilience is very high to residual reservoir hydrocarbon discharges from well clean-up and testing operations. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the residual reservoir hydrocarbons in the water column are anticipated. Any changes to the plankton community are anticipated to be immeasurable / undetectable. Effects on plankton due to the residual reservoir hydrocarbons from well clean-up and testing operations are therefore assessed as **Negligible**.

Fish

The sensitivity of fish to the planned discharge of residual reservoir hydrocarbons from well clean-up and testing operations is considered to be **Low**. The receptor has a high value; the fish community in the vicinity of the Victory location is of commercial importance on a national level. However, the residual reservoir hydrocarbons are not expected to persist within the marine environment and fish do have some tolerance / ability to avoid, adapt and recover from hydrocarbon pollution. The magnitude of impact is considered to be **Negligible**, as the rapid dilution of the residual reservoir hydrocarbons in the water column are anticipated. Any changes to the fish community are anticipated to be immeasurable / undetectable. Effects on fish due to the residual reservoir hydrocarbons from well clean-up and testing operations are therefore assessed as **Negligible**.

10.3 Mitigation Measures

Impacts from marine discharges during the development of the Victory field will be minimised by the implementation of the following mitigation measures:

- A chemical risk assessment will be undertaken to identify the risk profile of chemicals to be used and / or discharged in accordance with the requirements of the Offshore Chemicals Regulations 2002 (as amended). Where practicable, chemicals with a higher risk profile will be substituted out in favour of those with an improved environmental profile;
- Chemical use and discharge will be minimised to as low as practically possible;
- During drilling operations, cuttings / mud cleaning equipment will ensure optimal cuttings cleaning prior to discharge and recovered WBM will be reused/ re-circulated where practical. In addition, WBM will be mixed offshore to ensure that only what is required is used;
- During the drilling operations, any discharges of residual reservoir hydrocarbons will be treated to meet oil-in-water limits of less than or equal to 30 mg/l. The discharge stream will also be monitored and sampled in accordance with an approved Oil Discharge Permit.

10.4 Residual Effects

In summary, no significant residual effects on water quality, plankton and fish / shellfish are predicted as a result of routine marine discharges during the development of the Victory field. All chemicals will be risked assessed prior to use to ensure that there are no significant risks to the marine environmental upon discharge and any discharges of residual reservoir hydrocarbons will be treated to meet oil-in-water limits of less than or equal to 30 mg/l.

10.5 Transboundary Effects

Given the distance to the nearest transboundary line; the UK/Faroe median line around 110 km to the north west of the Victory field, it is very unlikely that marine discharges generated during the proposed development operations would lead to transboundary impacts, as it is anticipated that discharges will be diluted rapidly within close proximity (i.e. within 500 m) to their release location.

10.6 Cumulative Effects

The Victory development lies within an area of fairly low oil and gas activity (refer to Section 4.4.3), with the closest producing surface infrastructure being the Clair Ridge platform located approximately 41 km south west of the proposed Victory well. Therefore, given this distance, no cumulative impacts are expected given that most marine discharges from the Victory development will be diluted rapidly within close proximity to their release location. In addition, any marine discharges during drilling, installation and commissioning activities will be temporary in nature.

11 Accidental Releases

11.1 Introduction

This section assesses the risk of a worst case release occurring from the Victory development and the potentially significant environmental and socio-economic effects that could occur as a result. It also details the control and mitigation measures that will be implemented to both reduce the risk of an incident occurring and limit the potential impacts in the event that a spill did occur. It should be noted that in planning its activities, a primary focus of Corallian is to ensure that all practicable measures are taken to prevent the occurrence of accidental events and, should they occur, mitigate their effects. The risk of an accidental release of hydrocarbons occurring from the Victory development will be minimised through the implementation of physical barriers such as safety valves, maintenance to minimise leaks, and the implementation of handling and operational procedures and training to influence human behaviours. Measures to respond to a spill from the Victory field if an incident did occur will be covered in an Oil Pollution and Emergency Plan (OPEP), approved by the Offshore Major Accident Regulator (OMAR) under The Merchant Shipping (Oil Pollution Preparedness, Response and Cooperation) Regulations 1998 (as amended) in advance of the proposed development operations commencing.

11.2 Sources and Likelihood of Accidental Releases

11.2.1 Historic UKCS Data for Hydrocarbon Releases

On the UKCS, all accidental oil releases to the marine environment, regardless of their size, are reportable to BEIS through the submission of a Petroleum Operations Notice 1 (PON 1). Analysis of long-term data, over the last 30 years, highlights a shift towards ever smaller spill volumes and a reduction in the number of spill reports per year. However, the amount of oil accidentally released to the marine environment varies over recent years (2011 – 2020), highlighting the sensitivity of these data to single, low-frequency, high-mass events.

In 2020, there were 200 accidental oil releases on the UKCS, where over 268 tonnes of oil were released to the marine environment. To put this into context, in the same year, about 2,234 tonnes of oil were discharged to sea in produced water, under permit. This means that accidental oil releases represented 12 % of the total oil that entered the sea. Given that 80 million tonnes of oil were produced in the UKCS during 2020, accidental oil releases represented less than 0.0003 % of total oil production (OGUK, 2021).

Despite a decrease in the overall number of oil releases from 235 in 2019 to 200 in 2020, the total mass of oil released in 2020 was significantly higher, compared to 26 tonnes recorded in 2019. This is due to a single incident which released 238 tonnes. Without this incident, there would have been a slight increase of 4 tonnes year on year. The average annual reported accidental oil release size has varied since 2011, from a low of 0.05 tonnes to a high of 2.1 tonnes. Infrequent but large releases form a big part of annual totals, which was the case also in 2020. Oil releases of more than 50 tonnes have made up less than 0.22 % of the total number of releases, but over 75 % of the total mass released. Diesel was the most common hydrocarbon type released in 2020, followed by crude oil then lubricating oil (OGUK, 2021).

11.2.2 Victory Field Development Accidental Release Scenarios

It is considered that the following accidental release scenarios have the potential to result in significant environmental and socio-economic effects during development of the Victory field:

- Well blowout (releasing large quantities of condensate and gas) in the event of a loss of well control;
- MODU or vessel collision releasing the entire inventory of diesel;
- Pipeline rupture and subsequent release of condensate and gas to sea.

The likelihood of these unplanned events occurring is discussed below, using the Likelihood of Occurrence criteria defined in Section 5.3.2

Likelihood of a Well Blowout

A blowout is an extremely rare event where total failure of all pressure control systems and related processes can result in an uncontrolled flow of oil or natural gas (or a mixture of the two) at the rig floor as a result of BOP failure. Such an event can only take place if all drilling processes and controls are ignored in the course of drilling into a hydrocarbon reservoir or whilst operating with the reservoir formations open within the well.

Following the 2009 Montara and the 2010 Deepwater Horizon/Macondo well control incidents, EU Directive 2013/30/EU on the safety of offshore oil and gas operations has come into force, which is implemented in the UK through the Offshore Installations (Offshore Safety Directive) (Safety Case etc) Regulations 2015 (SCR 2015). The main aim of SCR 2015 is to reduce the risks from major accident hazards, such as a blowout, to the health and safety of the workforce employed on offshore installations or in connected activities. In addition, SCR 2015 also aims to increase the protection of the marine environment and coastal economies against pollution and ensure improved response mechanisms in the event of such an incident.

For a hydrocarbon influx (or kick) to develop into a blowout it would need to be undetected by the trained drilling crew despite multiple safety systems and alarms to identify a kick at the point of it occurring. In addition the crew would have to fail to operate the BOP rams or the BOP system would need to fail mechanically. A kick generally results from a scenario where the pressure of the oil/gas in the formations is higher than the hydrostatic pressure created by the drilling fluid (mud) in the well. A kick can only progress to a blowout via failure of all systems and processes that exist to prevent this occurring. Whilst blowouts are extremely rare, data indicates that they most frequently occur when drilling into an unexpected shallow gas pocket or whilst drilling a deep, high-pressure gas well, situations more common in wildcat exploration wells.

Notwithstanding the fact that the risk of a blowout on the UKCS is remote, the well design and planned operations on the proposed Victory well further reduce this risk. On many wells, for example where a mechanical plug or barrier is run, an inflow test is performed where the hydrostatic pressure above the barrier is reduced under controlled conditions until it is lower than the formation pressure. This confirms that the barrier in question is capable of holding the pressure within the formation. If the barrier were to have an undetected leak a blowout may occur; this was the cause of the blowout on Macondo in the Gulf of Mexico. However, an inflow test on a well suspension barrier of this type will not be performed on the Victory well. An inflow test will however be performed on the lower completion and isolation valve during the planned wellbore clean-up operation, as part of the essential integrity checks for the well. In addition, a well test is planned for Victory, where the hydrostatic will be dropped below the formation pressure to initiate production, as is normal on all development wells. The shallow, low pressure reservoir encountered in the Victory discovery well make the proposed Victory development well operationally very low risk.

Table 11.1 presents blowout frequencies for the North Sea (UK, Dutch and Norwegian sectors). This indicates that for development drilling (on average), the blowout frequency is extremely low at 2.37 x 10^{-5} per drilled well. It should be noted that drilling of development wells carries significantly lower risk of experiencing a blowout than exploration wells due to the extensive knowledge of the area already gained from nearby wells (Acona, 2012).

In summary, given the above, the likelihood of a blowout occurring at the Victory field is considered to be **Extremely Rare**.

Table 11.1: Blowout Frequencies (data from SINTEF Offshore Blowout Database 2010 cited in Scandpower, 2011 cited in Petroleumstilsynet, 2011)

Operation	Well Category	Frequency, Average Well	Frequency, Gas Well	Frequency, Oil Well	Unit
Production Drilling	Normal	2.37×10^{-5}	2.16×10^{-5}	2.62×10^{-5}	per drilled well
	HPHT Note 1	1.47×10^{-4}	1.34×10^{-4}	1.62×10^{-4}	per drilled well
Completion	-	1.49×10^{-4}	2.1×10^{-4}	8.4×10^{-5}	per operation
Wirelining	-	7.0×10^{-6}	1.0×10^{-5}	4.0×10^{-6}	per operation
Coil Tubing	-	1.5×10^{-4}	2.1×10^{-4}	8.4×10^{-5}	per operation
Snubbing	-	2.4×10^{-4}	3.4×10^{-4}	1.3×10^{-4}	per operation
Workover	-	2.5×10^{-4}	3.6×10^{-4}	1.4×10^{-5}	per operation
Producing Wells Note 2	-	7.9×10^{-5}	1.5×10^{-4}	1.5×10^{-5}	per well year

Note 1: HPHT – High Pressure, High Temperature
Note 2: Excludes external causes such as ship collisions

Likelihood of an MODU or Vessel Collision

During development of the Victory field there is the potential for a MODU and /or vessel collision, resulting in the entire loss of fuel inventory. The risk of collision will be highest when the MODU is moored on location at Victory and when the pipeline and umbilical are installed. A full collision risk assessment will therefore be undertaken by Corallian to inform the Consent to Locate (CTL) permit applications, required to site the MODU and subsea infrastructure at the Victory location.

In addition, information on the location of the drilling rig and associated anchor pattern, 500 m safety zone, subsea infrastructure and vessel operations will be communicated to other sea users (via the United Kingdom Hydrographic Office) through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings.

Corallian proposes to utilise up to three guard vessels (each patrolling a stretch up to 10 km in length) during the pipeline and umbilical installation activities, prior to the deposit of protection (rock) on top of the lines, to ensure that other sea users are aware of the ongoing operations. Vessels involved in installation operations will also update their marks, lights and navigational status broadcast on AIS to indicate to other vessels when they are restricted in manoeuvrability. This will assist any passing vessels that encounter the installation vessels.

Given the above mitigation measures, the likelihood of a MODU or vessel collision is considered to be **Unlikely**.

Likelihood of a Pipeline Rupture

Accidental releases of hydrocarbons or chemicals from subsea infrastructure (including pipelines, flowlines and umbilicals) are most likely to occur as a result of structural failures of equipment (i.e. corrosion). Releases due to impact damage are considered rare.

Historic data for the period between 2001 and 2012, records a total of 183 loss of containment events from pipelines and umbilicals on the UKCS (PARLOC, 2012). Approximately 43 % of the leaks recorded from flexible flowlines were from the body of the pipeline, while 38 % were from "other" sources and a further 10 % were from connections (i.e. flanges or welds). The average loss of containment frequency (i.e. how many spills per km of pipeline) and rupture frequencies for flexible flowlines, steel pipelines and umbilicals during this period is detailed in Table 11.2.

Table 11.2: Estimated Pipeline Loss of Containment and Rupture Frequencies (2001 -2012) (PARLOC, 2012)

Pipeline Type	Average Loss of Containment Frequency (per km-year)	Rupture Note 1 Frequency (per km-year)
Flexible Flowline (all diameters and length)	5.47×10^{-3}	9.8×10^{-4}
Steel Pipelines (all diameters and lengths)	4.23×10^{-4}	4.0×10^{-5}
Control Umbilicals (all lengths)	1.0×10^{-3}	(no data)

Note 1: Line ruptures are generally assumed to have a hole diameter equal to the pipeline's nominal diameter (PARLOC, 2012).

Worst case release scenarios would involve the loss of containment of the entire inventory of the pipeline; however these types of events are rare. Data from the Worldwide Offshore Accident Database (WOAD) for the period from 1970 to 2007 indicates that worldwide there have only been two major accidents resulting in the total loss of inventory from a pipeline. Both of these events were recorded in the North Sea (Europe), during transfer operations and involved 'loss of buoyancy or sinking' (OGP, 2010).

In summary, the likelihood of a pipeline rupture is considered to be **Rare**.

11.3 Fate of Spills in the Marine Environment

11.3.1 Oil Properties and Weathering Processes

When oil is spilled at sea it normally spreads out and moves on the sea surface with the wind and currents. At the same time, a number of natural processes take place; collectively termed weathering, these process change the physical and chemical properties of the oil and determine its fate in the marine environment. The weathering of oil depends on the chemical and physical properties of the oil (e.g. density, viscosity, wax content and pour point), the weather conditions (e.g. wind, waves, temperature and sunlight) and the properties of the seawater (e.g. salinity, temperature and bacterial flora).

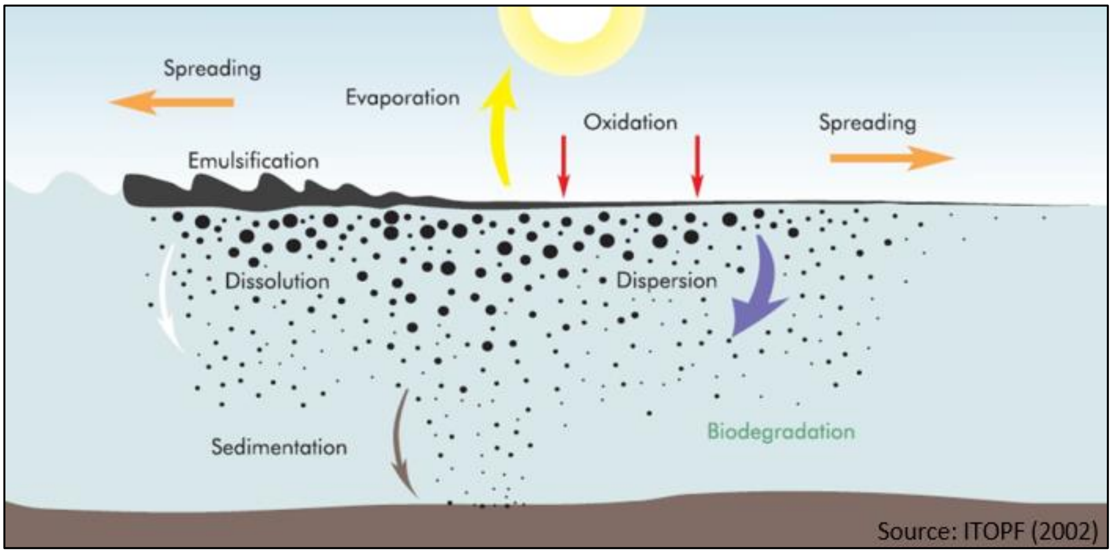
The International Tanker Owner Pollution Federation (ITOPF) has ranked oils according to their physical characteristics (API/SG) and likely spill behaviour (Table 11.3). The hydrocarbons present in the Victory reservoir are predominantly dry gas, with very small amounts (circa. 1 bbl / million standard cubic foot) of associated light condensate (85˚ API; categorised as a Group 1 oil). Light oils such of these are more susceptible to evaporation and oxidation and consequently reduce faster over time compared to heavier oils.

Table 11.3: ITOPF Categories and Characteristics

Group	Specific Gravity	API	Viscosity (cSt)	Typical Examples	Scale
1	< 0.8	> 45˚	< 3	Gasoline products	Light
2	0.8 - 0.85	35˚ - 45˚	4 (semi solid)	Diesel-like products, light crude	
3	0.85 - 0.95	17.5˚ - 35˚	8 (semi solid)	Medium crude, North Sea crude (e.g. Forties)	
4	> 0.95	< 17.5˚	1,500 (semi solid)	Heavy crude and residual oils	Heavy

There are eight main oil weathering processes: spreading, evaporation, dispersion, emulsification, dissolution, sedimentation, oxidation, and biodegradation. The effects of spreading, evaporation, dispersion, emulsification and dissolution are most significant early on in a spill whilst oxidation, sedimentation and biodegradation are more significant later (Figure 11.1) (ITOPF, 2014).

Figure 11.1: Oil Weathering Process



Over time, as a consequence of weathering, an oil spill will normally break up and begin to dissipate into the marine environment. Light products such as the Victory condensate and diesel under most conditions, evaporate and dissipate quickly and naturally.

11.3.2 Oil Spill Modelling

Although extremely rare, a well blowout event is considered to be the worst case accidental release scenario that could occur as a result of the Victory field development. Therefore, in order to gain an understanding of the fate of the Victory condensate in the marine environment, the following scenario has been modelled:

- Subsea blowout with a cumulative release of 5,247 m^3 (33,000 bbl) of 85°API after 60 days with a release rate of 550 bbl / day.

This represents the worst case scenario for the Victory field in terms of both the volume of hydrocarbons which would be released and the duration of the spill (i.e. it assumes a relief well would need to be drilled to bring the well back under control). It should be noted that this is an extreme worst case that assumes the complete failure of all control and preventative measures. In a real situation, steps would immediately be taken to stem the flow of hydrocarbons and in the event of a well control incident bring the well back under control. A counter-pollution response strategy would also be developed and initiated, which would aim to prevent significant quantities of hydrocarbons beaching on the shoreline.

The oil spill modelling has been undertaken with the use of OILMAP, an advanced oil modelling tool developed and licensed by RPS ASA, which provides predictions of the fate and transport of spilled hydrocarbons and calculates the probability of key areas being impacted.

To simulate a range of possible metocean conditions, stochastic results were calculated from over 100 trajectory runs per season. This provides insight into the range of probable behaviours of a potential oil spill in response to varying meteorological and oceanographic conditions in the study area. Stochastic modelling computes surface trajectories for an ensemble of many individual cases for each spill scenario. Each individual simulation start time is selected randomly, thus sampling the variability in the wind and current forcing. The stochastic model results that have been reported in the assessment include the following:

- The probability and minimum time for surface oiling (with a minimum thickness threshold of 0.3 µm). A surface thickness 0.3 µm is the minimum threshold identified by the Bonn Agreement Oil Appearance Code (BAOAC) capable of producing a visible rainbow sheen. The 0.3 µm threshold value is required by the OPEP guidance notes (BEIS, 2021) and is the chosen value for when potential significant environmental impacts may begin to occur.

- The probability and minimum time for water column oiling (with a minimum concentration threshold of 1 ppb). A concentration of oil in water above 1 ppb is the minimum threshold identified for screening potential effects on sensitive organisms and socio-economic activity (e.g. seafood production).
- The probability and minimum time for shoreline oiling (with a minimum thickness threshold of 1.0 µm). A shoreline thickness 1.0 µm is the minimum threshold identified for potential effects on socio-economic resource uses, as this amount of oil may conservatively trigger the need for shoreline clean-up on amenity beaches (French-McCay, *et al*. 2011 and French-McCay, *et al*. 2012).

It is important to note that the stochastic modelling results do not represent a single spill event, and instead show the aggregation of results computed by running the spill scenario multiple times (i.e. 100 times) over different weather conditions.

To analyse single spill scenarios, trajectory modelling was undertaken for each season by extracting the worst case simulation run from the stochastic results. The worst case trajectory simulation was identified by the greatest mass of shoreline oiling at any one location after 70 days. The trajectory modelling enables fates analysis on the released condensate over time.

The input parameters and modelling results are presented in full in Appendix B. A summary of the key conclusions has been provided below.

Stochastic Modelling Results

Surface Oiling

Table 11.4 reports the maximum probability, minimum time and the maximum distance that the surface oil slick may occur from the Victory release location for each of the BAOAC thresholds. This data is displayed graphically in Appendix B.

Table 11.4: Surface Oiling by BAOAC Thresholds

Code	Description – Appearance	Layer Thickness Interval (µm)	Litres per km^2	Maximum Probability of Surface Oiling	Minimum Time to Surface Oiling	Max Distance from the Release Location
1	Sheen (silvery/grey)	0.04 to 0.30	40 – 300	N/A	N/A	N/A
2	Rainbow	0.30 to 5.0	300 – 5000	63 %	63 hrs	447 km
3	Metallic	5.0 to 50	5000 – 50,000	92 %	28 hrs	287 km
4	Discontinuous True Oil Colour	50 to 200	50,000 – 200,000	100 %	23 hrs	169 km
5	Continuous True Oil Colour	More than 200	More than 200,000	100 %	15 hrs	105 km

The probability of surface hydrocarbons having a thickness above 0.3 µm is modelled to be >75 % up to 83 km from the release source; >50 % up to 115 km from the source and between 1-10 % up to 447 km from the source.

There is a low probability of surface oil crossing the Norwegian (5 – 9 %) and Faroe Islands (1 – 5 %) median lines (Table 11.6). Norwegian waters may experience BAOAC 3 (metallic coloured oiling) and Faroe Islands waters may experience BAOAC 2 (rainbow coloured oiling). The minimum time for surface oil to reach the Norwegian and Faroe Islands median lines is 135 hours and 119 hours, respectively.

Subsurface Oiling

Table 11.5 presents thresholds of concern for oil in water concentrations taken from referenced literature and reports the maximum distance that subsurface oil may occur from the release location for each referenced threshold concentration. This data is displayed graphically in Appendix B.

Table 11.5: Maximum Distance that Subsurface Oil may occur from Release Source at Various Severity Concentration Thresholds

Water Column Oil Concentration (ppb)	Threshold Justification (refer to Appendix B for detailed justification)	Max Distance from Release Location
1	Screening threshold (Minimum Water Column Concentration modelled) (Trudel, 1989; French-McCay, 2002; French-McCay, 2004; French-McCay, *et al.,* 2012).	588 km
58	Conservative lethal exposure threshold for marine fauna (Nilsen *et al*., 2006).	8 km
70.5	OSPAR recommended predicted no-effect concentration threshold for marine fauna (Smit *et al*., 2009; OSPAR, 2014)	7 km
100	Lethal effect level on cod (*Gadus morhua*) larvae (Vikebø *et al*., 2013).	4 km

The probability of subsurface hydrocarbons having a concentration above 1 ppb is modelled to be >75 % up to 95 km from the release source; >50 % up to 112 km from the source and between 1-10 % up to 588 km from the source.

There is a low probability of subsurface oil crossing the Norwegian (6 – 16 %) and Faroe Islands (1 – 6 %) median lines (see Table 11.6). It is predicted that the subsurface oil present within the waters of Norway and the Faroe Islands will be of low severity, below the 58 ppb concentration threshold described in Table 11.5. The minimum time for subsurface oil to reach the Norwegian and Faroe Islands median lines is 209 hours and 177 hours, respectively.

Shoreline Oiling

The modelling predicts that shoreline oiling will occur in the Shetland Islands across all seasons. The maximum probability of shoreline oiling on the Shetland Islands occurs during the autumn with a 28 % chance. The minimum time to shore occurs during the winter, with oil reaching the coastline within 50 hours (Table 11.6).

There is a 1 % probability of shoreline oiling occurring in Norway during winter and autumn with a minimum time to impact of 426 hours (Table 11.6).

All modelled shoreline oiling is of low severity and classified as 'light oiling' under the ITOPF (2014a) classification.

Table 11.6: Summary of Stochastic Modelling Results

Scenario 1: Subsea Well Blowout in the Victory Field					
Spill Scenario / Descriptor: 33,000 bbl of Condensate (85 °API) released over 60 days					
Season		Winter (December – February)	Spring (March – May)	Summer (June – August)	Autumn (September – November)
Median Crossing Note 1					
Identified Median Line	**Surface Oil: Probability and Shortest Time to Reach (Minimum Thickness of 0.3 µm)**				
Norway	*Maximum Probability*	7 %	5 %	7 %	9 %
	Shortest Arrival Time	135 hrs	182 hrs	176 hrs	186 hrs
Faroe Islands	*Maximum Probability*	3 %	5 %	2 %	1 %
	Shortest Arrival Time	149 hrs	292 hrs	119 hrs	308 hrs
Identified Median Line	**Subsurface Oil: Probability and Shortest Time to Reach (Minimum Water Column Concentration 1.0 ppb)**				
Norway	*Maximum Probability*	8 %	6 %	8 %	16 %
	Shortest Arrival Time	240 hrs	209 hrs	212 hrs	232 hrs
Faroe Islands	*Maximum Probability*	1 %	6 %	4 %	1 %
	Shortest Arrival Time	946 hrs	488 hrs	177 hrs	955 hrs
Landfall Note 1					
Predicted Locations	**Shoreline Oil: Probability and Shortest Time to Reach (Minimum Thickness of 1.0 µm)**				
Norway	*Maximum Probability*	1 %	N/A	N/A	1 %
	Shortest Arrival Time	426 hrs	N/A	N/A	1,011 hrs
Shetland Islands Note 2	*Maximum Probability*	23 %	10 %	5 %	28 %
	Shortest Arrival Time	50 hrs	135 hrs	257 hrs	86 hrs

Note 1: Shortest arrival time and maximum probability values are not necessarily linked to the same run. The results represent a worst case scenario for each feature based on the analysis of all model runs.
Note 2: Refer to Appendix B for predicted locations within the Shetland Islands.

Worst Case Trajectory Results Summary

The worst case trajectory simulations were identified per season by the greatest volume of oil beached in any one location, as detailed in Table 11.7. The worst case trajectory simulations have been displayed graphically in Appendix B showing the total swept area of surface and shoreline oiling.

Table 11.7: Worst Case Trajectory Simulations Identified from Stochastic Results

Season	Run No	Greatest Volume of Oil Beached (in any one location)			Sim Start Date	Sim Start Time	Time (hrs) to Impact
		m^3	bbl	tonnes			
Winter	67	5.3	33.33	3.47416	05/12/2016	18:00	665 hrs
Spring	33	0.4	2.52	0.27383	29/04/2008	03:00	1,045 hrs
Summer	10	0.1	0.63	0.09400	07/08/2012	15:00	1,496 hrs
Autumn	89	4.8	30.19	3.11705	19/11/2016	16:00	153 hrs

Table 11.8 provides summary statistics for the worst case trajectory simulations. The fate of released condensate after 70 days is consistent between seasons. The released condensate does not persist in the marine environment with the majority evaporated (circa. 70 – 72 %) and degraded (circa. 25 – 27 %) after 70 days. Only a small proportion (circa. 2 %) of released condensate remains in the water column after 70 days. The trajectory simulations predict zero condensate in the sediment and on the sea surface after 70 days. The winter trajectory simulation has the greatest proportion (0.09 %) of shoreline oil after 70 days.

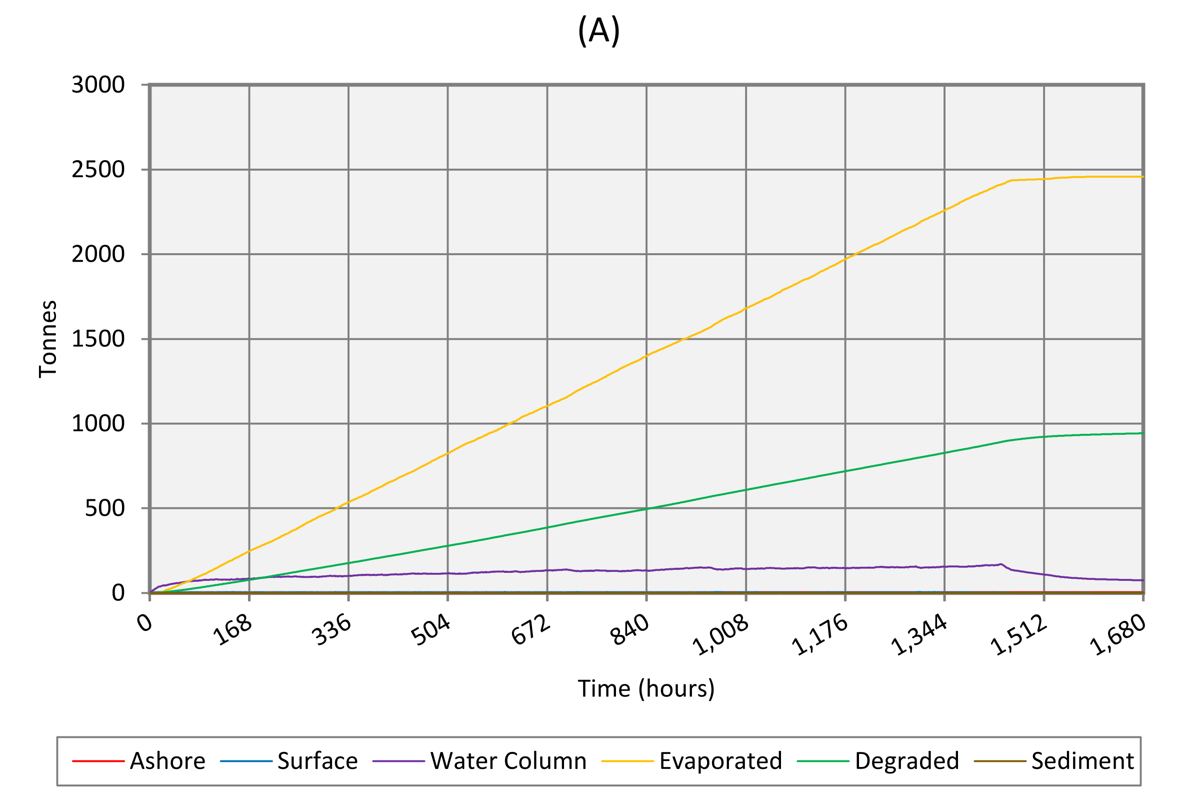
Figure 11.2 (A) and (B) shows the fate of released condensate (mass balance) over time for the winter trajectory simulation (the worst case season for shoreline oiling). After 60 days (1,440 hours) the condensate blowout release stops and the proceeding 10 days show a decline in surface oil (from 1.62 tonnes to 0 tonnes) and subsurface oil (from 169.6 tonnes to 74.4 tonnes). Thus highlighting the short persistence of the released condensate in the marine environment.

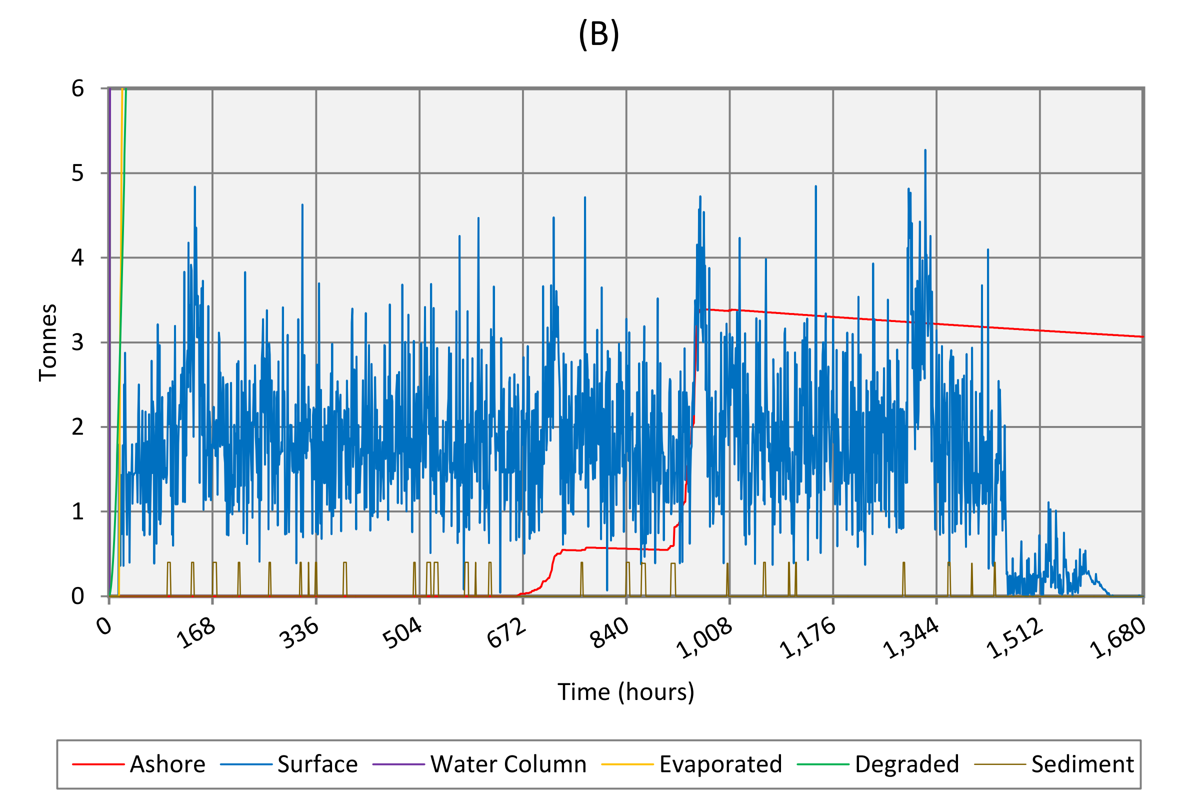
Table 11.8 reports a maximum surface slick area between 17 – 20 km^2 across all seasons. However, the maximum surface slick area is short lived due high evaporation rates. Figure 11.2 (B) shows that the surface oil at any one time during the winter simulation is less than 5.3 tonnes, indicating that the worst case slick area is of low severity (i.e. 5.3 tonnes / 17 km^2 = 0.312 tonnes / km^2) equivalent to BAOAC 2 (rainbow coloured oiling). The seabed sediment is subject to a very small amount of condensate oiling (maximum 0.4 tonnes) at any one time during the spill duration (Figure 11.2 (B)).

Table 11.8: Fate Analysis Summary for Trajectory Simulations

Season	Trajectory Run No.	Minimum Time for Surface Oiling	Maximum Surface Slick Area	Minimum Time for Shoreline Oiling	Impacted Length of Coastline after 70 days	Fate of Released Condensate after 70 days (% of total release)					
						Ashore	Surface	Water Column	Evaporated	Degraded	Sediment
Winter	67	16 hrs	17 km^2	665 hrs	39.88 km	0.09	0.0	2.14	70.67	27.10	0.0
Spring	33	15 hrs	18 km^2	1,045 hrs	5.66 km	0.01	0.0	2.10	72.11	25.78	0.0
Summer	10	14 hrs	18.5 km^2	1,496 hrs	3.17 km	0.0	0.0	2.11	72.41	25.48	0.0
Autumn	89	15 hrs	20 km^2	153 hrs	37.04 km	0.08	0.0	2.09	72.03	25.80	0.0

Figure 11.2: Fate of Released Condensate over Time (Mass Balance) during winter (Run No. 67) (Graph A: y-axis scale 0-3,000 tonnes; Graph B: y-axis scale 0-6 tonnes) Note 1





Note 1: The y-axis scale in Graph B has been restricted to 0-6 tonnes to show ashore, surface and sediment oiling over time.

11.4 Environmental and Socio-Economic Effects

The potential effects of spills on the marine environment depend on the nature and volume of the hydrocarbons spilt, the extent of weathering in the marine environment, and the sensitivity of the species exposed to the spill (ITOPF, 2014b). Oil spills can affect the marine environment directly through physical smothering of marine organisms and toxicity impacts, and also indirectly through loss of habitat, shelter, or key species in communities, altering community structure and loss of prey (ITOPF, 2014b). The marine environment is highly dynamic and complex. Many species are exposed to fluctuating environmental conditions and therefore have a degree of intrinsic tolerance to environmental stressors, including pollution. However, chronic stressors can reduce the resilience of individuals and communities.

In addition, economic losses can be experienced by industries and individuals dependent on offshore or coastal resources. Usually, the tourism and commercial fisheries sectors are where the greatest impacts are felt (ITOPF, 2014c).

Given the variety of factors that can affect the behaviour of spilt hydrocarbons, accurate predictions of effects before a spill has actually occurred are difficult to make. However, a summary of the potential effects that could occur in the event of a worst case condensate blowout release during drilling of the Victory well has been provided below based on the oil spill modelling results (see Section 11.3 and Appendix B) and the known environmental and socio-economic sensitivities present in the area.

11.4.1 Water Quality

There is the potential that a worst case release of hydrocarbons from the Victory well could result in damage that would significantly adversely affect the ecological, chemical and/or quantitative status and/or ecological potential, as defined in Directive 2006/60/EC or the environmental status of marine waters as defined in Directive 2008/56/EC.

Low viscosity hydrocarbons such as the Victory condensate are expected to disperse naturally through the water column, particularly in a subsea release scenario. The released condensate will be dispersed over a wide area by currents, wave action and wind. Once the condensate reaches the sea surface (typically 14 – 16 hours after release, refer to Table 11.8) it is subject to very high evaporation rates due to the light nature of the hydrocarbon. Surface oil may be severe with patches of BAOAC 5 – Continuous True Oil Colour at distances up to 105 km from the release location (Table 11.4); however, the quantity of oil on the surface is relatively small (<5.3 tonnes of surface oil at any one time). The condensate has a low asphaltene content which prevents emulsification, reducing its persistence in the marine environment as shown in Table 11.8 and Figure 11.2.

Modelling results show that the water column would be impacted over a relatively wide area (up to 588 km from the release location with a 1 ppb hydrocarbon concentration). The 1 ppb hydrocarbon concentration was used as the minimum screening threshold in the oil spill modelling (refer to section 11.3.2 and Table 11.5). Although potential effects to sensitive organisms and socio-economic activity may be detectable at a 1 ppb hydrocarbon concentration, mortality to marine fauna is not expected. Nilsen *et al*. (2006) found a 58 ppb Total Hydrocarbon Concentration (THC) is a conservative lethal exposure value for marine fauna. A 58 ppb THC is limited to 8 km from the release location (refer to Table 11.5). Therefore, significant concentrations of condensate are not anticipated to reach coastal waters. In addition, modelling predicts that ten days after the end of the subsea blowout release, only circa. 2 % (74.4 tonnes) of the condensate would remain in the water column. Further dilution, dispersion and biodegradation would continue to reduce concentrations of condensate in the water column.

In summary, the sensitivity of water quality to a worst case condensate blowout is considered to be **Medium**. The receptor has a <u>Very High value</u> as it is of international importance. However, the West of Shetland area is characterised by persistent, long-period swells, complex current regimes and rapidly changing weather conditions. The water quality is subject to rapid refreshment rates and mixing of the water column, coupled with strong wave action on the sea surface. Therefore, the receptor <u>resistance and resilience is Very High</u> to condensate pollution. The magnitude of impact is considered to be **Moderate**, as the condensate spill may travel great distances (up to 477 km on the sea surface and 588 km in the water column), but any impact will be temporary in nature. The released condensate does not persist and modelling shows rapid recovery towards baseline conditions in the ten day duration after the blowout cessation. Effects on water quality due to the worst case blowout scenario are therefore assessed as **Minor**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to water quality from a well blowout is considered to be **Low**.

11.4.2 Sediment Quality

The Victory condensate would be subject to rapid dispersion and biodegradation upon release, thus limiting the mass of condensate reaching and persisting within the seabed sediment. Modelling predicts that the seabed sediments would be subject to very small amounts of oiling (maximum 0.4 tonnes) at any one time during the spill duration (refer to Figure 11.2 (B)). The pattern shown in Figure 11.2 (B) strongly suggests that the minimal sediment oiling is occurring periodically in the very close vicinity of the 'subsurface' release location, before degrading or mixing into the water column. The condensate is very light (ITOPF Group 1 - 85° API) and rises to the sea surface very quickly (refer to Table 11.8 – minimum time to surface oiling 14-16 hrs from a depth of 150 m). Therefore it is very unlikely that sediment oiling would occur at great distance from the well release site. The trajectory simulations predict no condensate in the seabed sediments after the model simulation had completed (i.e. 10 days after the release had stopped). It is anticipated that concentrations of condensate in sediment will be below the OSPAR 50 ppm contamination threshold (OSPAR, 2006).

In summary, the sensitivity of sediment quality to a worst case condensate blowout is considered to be **High**. The receptor has a Very High value; sediments in the region are uncontaminated and the Faroe-Shetland Sponge Belt NC MPA designated for the protection of seabed features is within 8 km of the release location. However, it is anticipated that condensate will be subject to high biodegradation within the seabed sediment and recoverability will be in the medium term. Therefore, the receptor resistance and resilience is High to condensate pollution. The magnitude of impact is considered to be **Negligible**, as the worst case oil spill modelling revealed very small amounts of sediment oiling throughout the blowout scenario. Condensate in the seabed sediment does not persist and modelling shows immeasurable / undetectable changes in baseline conditions after the model simulation had completed. Effects on sediment quality due to the worst case blowout scenario are therefore assessed as **Negligible**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to sediment quality from a well blowout is considered to be **Low**.

11.4.3 Plankton

Plankton play a key role in marine and aquatic food webs. Changes in the plankton community can have knock-on effects on fauna feeding at higher trophic levels, such as fish, birds and cetaceans.

Phytoplankton and zooplankton occupy the upper layers of the water column are therefore more likely to be exposed to spilt hydrocarbons which tend to surface as they are less dense than water (ITOPF, 2014b). Phyto and zooplankton may be exposed to toxic water-soluble components from spills. Studies have shown growth inhibition in phytoplankton at hydrocarbon concentrations of 100,000 ppb. Conversely, lower levels of hydrocarbons, around 100 ppb, have been found to stimulate growth (Harrison *et al*., 1986). The modelling predicts water column oiling >100 ppb may occur within 4 km of the release location (Table 11.5) and the maximum water column oiling concentration is <250 ppb. Zooplankton at the surface are thought to be particularly sensitive to oil spills due to their proximity to high concentrations of dissolved hydrocarbon and to the additional toxicity of photo-degraded hydrocarbon products at this boundary (Bellas *et al*., 2013). As discussed in Section 11.3, the modelling predicts surface oiling to be short lived. The high evaporation rate limits the mass of surface oil to 5.3 tonnes at any one time. Therefore, limiting the exposure to zooplankton at the sea surface.

In general, plankton communities have been found to be highly resilient to the effects of spilt hydrocarbons (Abbriano *et al*., 2011) and their high turnover rate and reproduction is sufficient to make up for any losses of eggs and larval stages that may be lost through mortality in the vicinity of a spill (ITOPF, 2014b). In addition, there is evidence that some zooplankton (particularly copepods) can sense and actively avoid oiled areas, therefore reducing potential contact with oil (Seuront, 2010). Consequently, the potential for knock-on effects on fauna feeding at high trophic levels is not considered to be significant.

In summary, the sensitivity of plankton to a worst case condensate blowout is considered to be **Low**. The receptor is of Medium value; the plankton community has a regional importance to the Faroe-Shetland Channel, providing a food source to higher trophic levels in this region. However, condensate does not persist within the marine environment and the plankton has high recoverability in the short-term with high reproduction rates. Therefore, the receptor resistance and resilience is Very High to condensate pollution. The magnitude of impact is considered to be **Negligible**, as the worst case oil spill modelling revealed that the condensate does not persist and the worst case oiling concentrations (<250 ppb) are limited to with 4 km of the release location. Any changes to the plankton community are anticipated to be immeasurable / undetectable. Effects on plankton due to the worst case blowout scenario are therefore assessed as **Negligible**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to plankton from a well blowout is considered to be **Low**.

11.4.4 Seabed Communities

In response to hydrocarbon exposure, benthic fauna can either move, tolerate the pollutant (with associated impacts on the overall health and fitness), or die (Gray *et al*., 1988; Lee and Page, 1997). The response to hydrocarbons by benthic species differs depending on their life history and feeding behaviour, as well as the ability to metabolise toxins, especially PAH compounds. However, severe oil pollution typically causes initial massive mortality and lowered community diversity, followed by extreme fluctuations in populations of opportunistic mobile and sessile fauna (Suchanek, 1993).

As discussed in Sections 11.3 and 11.4.2, modelling predicts minimal oiling to the seabed with a maximum of 0.4 tonnes of condensate in seabed sediment at any one time during the spill duration. In addition, the condensate is subject to rapid dispersion and biodegradation upon release, thus limiting the mass of condensate reaching and persisting within the seabed sediment. It is therefore anticipated that seabed communities will be exposed to negligible volumes of condensate during and after the spill duration. Mass mortality and lowered community diversity to benthic species is not expected.

In summary, the sensitivity of seabed communities to a worst case condensate blowout is considered to be **High** as the habitats and species present are typical of this area. The receptors are of Very High value, due to the potential presence of ocean quahog, listed on the OSPAR list of threatened and/or declining species (see Section 4.3.2). However, the condensate does not persist and the benthic community does have some tolerance to hydrocarbon contamination and is expected to recover in the medium term. Therefore, the receptor resistance and resilience is High to condensate pollution. The magnitude of impact is considered to be **Negligible**, as the worst case oil spill modelling revealed very small amounts of seabed oiling throughout the blowout scenario. Condensate in the seabed sediment does not persist and modelling shows immeasurable / undetectable changes in baseline conditions after the model simulation had completed. Effects on seabed communities due to the worst case blowout scenario are therefore assessed as **Negligible**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to seabed communities from a well blowout is considered to be **Low**.

11.4.5 Fish

Fish (including eggs and larvae) may be affected by spilt oil in a number of ways; their gills may be contaminated with oil, planktivorous or piscivorous fish may consume contaminated prey and larvae or eggs may be susceptible to certain toxic and volatile components of oil (Neff, 1990). Free swimming adult fish however, tend to be less susceptible to the effects of an oil spill as they can detect it and move away from the affected area (ITOPF, 2014b). In addition, many fish species have developed systems which can metabolise and excrete aromatic hydrocarbons and therefore most fish do not tend to accumulate high concentrations of petroleum hydrocarbons, even in heavily oil-contaminated environments (Neff, 1990).

Juvenile fish and larvae are susceptible to the toxic effects of hydrocarbons that may cause larval mortality depending on the type of oil and the exposure time (Abbriano *et al*., 2011). Oil spills can result in high mortality, as well as genetic mutations, in fish eggs and larvae which are relatively immobile and are therefore more likely to be exposed to a spill for a longer period of time. Studies have shown that fish tainting from oil exposure can occur at oil concentrations from 10 ppb (GESAMP, 1993). Modelling predicts that water column oiling at a concentration >10 ppb could occur at distances up to 73 km from the release location (refer to Figure 11.3).

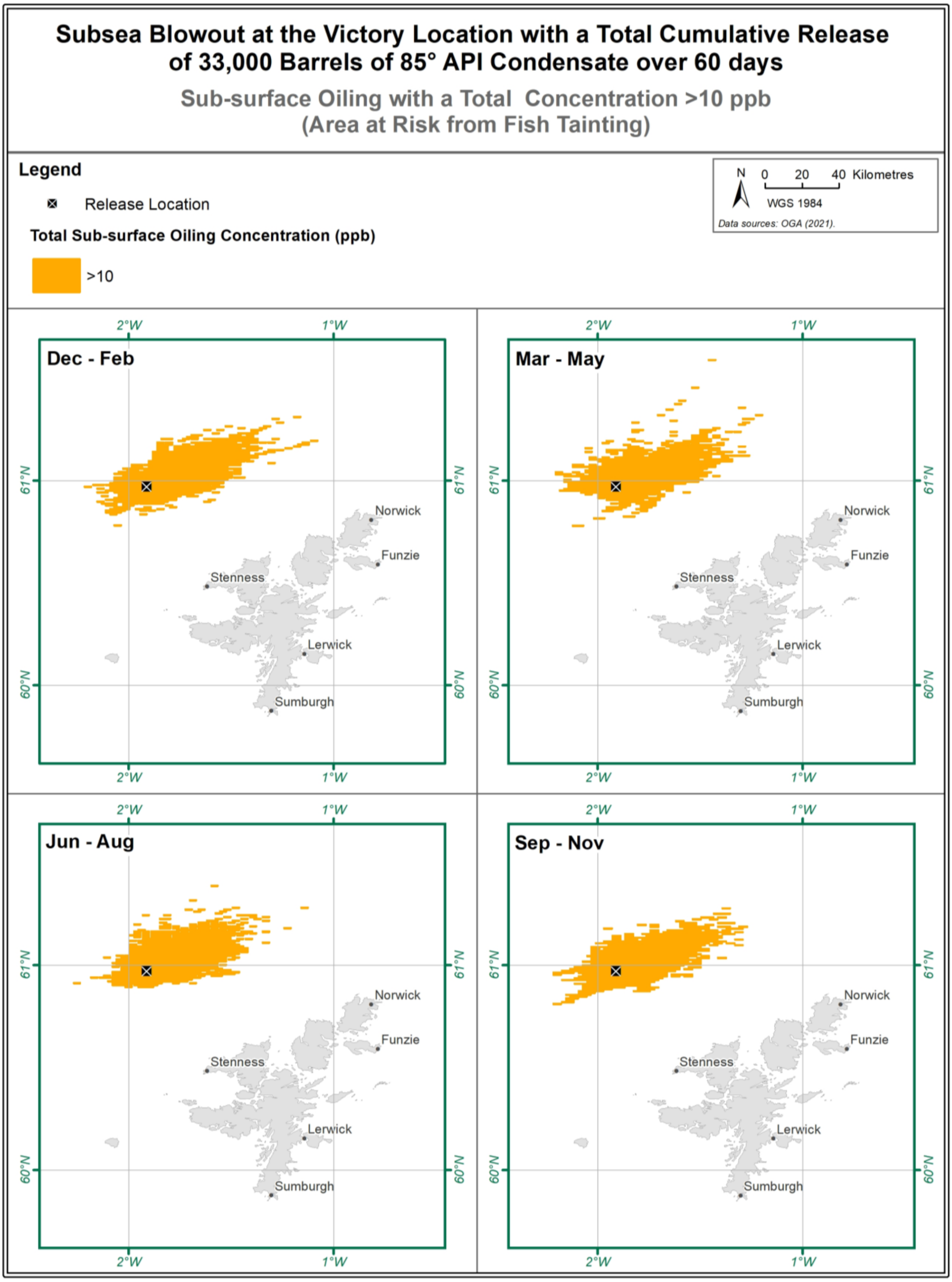
The chemical components of light oils, such as the Victory condensate, have a high biological availability and toxic impacts are more likely than from a heavy crude. Table 11.5 details various water column threshold concentrations. The 58 ppb concentration is a conservative lethal exposure value for marine fauna as it is below the LC_{50} for 95 % of species. The water column may experience oiling at this concentration at distances of up to 8 km from the release location. It is highly unlikely that mortality to fish will occur at a 58 ppb concentration. However, toxicological effects may be long lasting and contamination may lead to sub-lethal effects such as impaired feeding and reproduction (ITOPF, 2014b). In general, the likelihood of fish mortality from open water oil spills is small (IPIECA-IOGP, 2015). Significant effects on wild stocks have seldom been detected and fish are thought to actively avoid hydrocarbons (ITOPF, 2014b). Once the hydrocarbon disappears from the water column fish generally lose contamination from their tissues quickly due to their ability to metabolise accumulated hydrocarbons very rapidly (Krahn *et al*., 1993). As discussed in Section 11.3, the Victory condensate is not predicted to persist in the water column with high rates of evaporation and biodegradation. After 70 days only circa. 2 % (74.4 tonnes) of the condensate would remain in the water column and have the potential to contaminate fish species.

A condensate release could have the potential to impact fish spawning success because the eggs and larvae of many species are more sensitive to hydrocarbon toxins than adult fish. The eggs and larvae of broadcast spawners, which are widely dispersed (refer to Section 4.3.3), could be exposed to condensate in the water column. As discussed in Section 11.3, the modelling results show that the water column could be impacted over a relatively wide area. Fish species that are demersal spawners, could be exposed to condensate deposited on the seabed; however, as discussed in Section 11.4.4, minimal condensate is expected to be deposited on the seabed.

There are a number of fish spawning and nursery grounds with the vicinity of the Victory field development (see Section 4.3.3). This includes the following species listed as PMFs in Scottish waters: anglerfish (monkfish), blue whiting, cod, herring, horse mackerel, ling, mackerel, Norway pout, sandeels, spurdog and whiting (SNH, 2014; Tyler-Walters et al., 2016). However, many these species have a widespread distribution and their spawning and nursery grounds are not restricted to this area. It is important to note that any localised mortality of eggs and larvae following a spill rarely impacts wider populations. Even a large spill, coinciding with a geographically isolated spawning event, would be extremely unlikely to expose a notable proportion of the adult stock to a sustained lethal dose of hydrocarbons (IPIECA-IOGP, 2015). In addition, marine organisms are adapted to acute local impacts by the production of vast surpluses of eggs and larvae, and recruitment from outside the affected area (ITOPF, 2014b; IPIECA-IOGP, 2015).

In summary, the sensitivity of fish to a worst case condensate blowout is considered to be **Medium**. The receptor has a High value; the fish community in the vicinity of the Victory location is of commercial importance on a national level. However, the condensate does not persist and fish do have some tolerance / ability to avoid, adapt and recover from hydrocarbon pollution. Therefore, the receptor resistance and resilience is High to condensate pollution. The magnitude of impact is considered to be **Minor**, as the released condensate does not persist and modelling shows rapid recovery towards baseline conditions in the ten day duration after the blowout cessation. Effects on fish due to the worst case blowout scenario are therefore assessed as **Minor**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to fish from a well blowout is considered to be **Low**.

Figure 11.3: Area at Risk of Fish Tainting (Subsurface Oil Concentration >10 ppb)



11.4.6 Seabirds

The effects of oil on seabirds has been widely studied and includes both immediate chronic impacts which can kill birds or longer-term, sub-lethal, impacts that could affect individuals and populations over many years (e.g. Camphuysen *et al*., 2005; Perez, *et al*., 2009). Seabird species that raft together or spend a significant amount of time on the sea surface (such as auks) are particularly vulnerable to oil spills. A small spill during the breeding season or moulting season, when they cannot fly or where large populations of seabirds have congregated, can prove more harmful than a larger spill at a different area or time of year. Oiling of plumage can result in mortality due to hypothermia, loss of buoyancy and potentially drowning, as well as indirectly by reducing the bird's ability to take off and fly thereby potentially hindering their search for food or escape from predators (ITOPF, 2014b). A seabirds' instinctive response to oiling is to clean itself by preening and ultimately ingesting oil from its plumage. Seabirds may also be indirectly affected through the ingestion of contaminated prey.

The proposed Victory development is located within an important area for great skua and northern fulmar in the breeding season. An assessment of the median SOSI scores for the Victory development area shows that the sensitivity of seabirds to oil pollution is generally low between May and September, low to medium between November and February, high to very high in October and low to high in March (refer to Section 4.3.4). Of note, is that the coastal waters around the Shetland Islands hold vulnerable concentrations of seabirds all year round and are visited by several seabird species for feeding and breeding purposes. There are numerous seabird colonies which are designated as SPAs along the adjacent coastline to the Victory development and offshore, the Seas off Foula SPA is an important seabird foraging site West of Shetland, covering an area of 3,412 km^2. Modelling of a worst case condensate blowout release predicts that there is 3-8 % probability of surface oil (BAOAC 4 - Discontinuous True Oil Colour) entering the Seas off Foula SPA (Table 11.9).

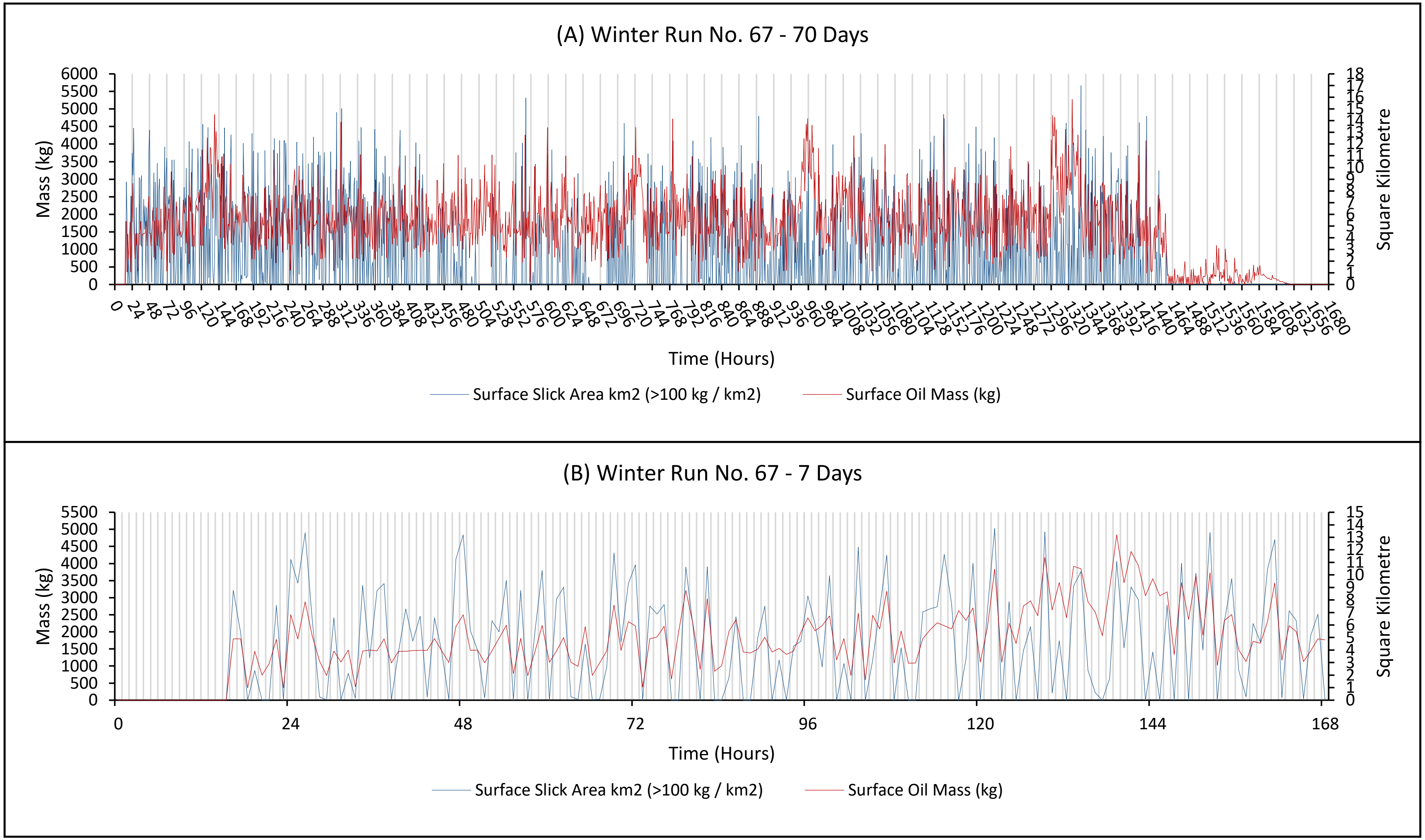
An oil sheen thickness >0.3 µm is the minimum thickness expected to produce negative impacts on marine fauna encountering released condensate at the sea surface. As noted in Section 11.3, surface oiling with a minimum thickness 0.3 µm may travel up to 477 km from the release source (albeit at low probabilities <10 %). There is >75 % probability of surface oiling (>0.3 µm) occurring within 83 km of the release source. In addition, the most severe (BAOAC 5 - Continuous True Oil Colour) surface oiling may occur within 105 km of the release location. Therefore, in the event of a well blowout in the Victory field, significant volumes of hydrocarbons may surface over a wide area and affect rafting birds.

Although stochastic modelling shows that surface oiling may occur over a wide area and at high severity it is not predicted to persist or accumulate. Figure 11.4 (A) and (B) presents the total surface oiling mass and surface slick area (with an oiling concentration >100 kg / km^2) over time for the winter trajectory run number 67. Of note, is the 100 kg / km^2 threshold is equivalent to BAOAC 1 – Sheen (silvery / grey). Figure 11.4 (A) shows the maximum surface slick area is 17 km^2 and up to 5,300 kg of surface condensate may be present and able to effect seabirds at any one time. Figure 11.4 (A) also shows that surface oil does not persist; once the blowout release stops at 1,440 hours (60 days) the surface oil reduces to zero in the following 10 days. Figure 11.4 (B) concentrates on the first week of the condensate release to demonstrate how the surface slick area fluctuates in a pattern of peaks and troughs. The peaks and troughs are a function of the time taken for released condensate to reach the sea surface and very high evaporation rates at the sea surface. Therefore, the surface slick is limited in size, growing and shrinking at regular intervals between 1 and 6 hour time gaps throughout the release scenario. The high evaporation rates limit the peak surface slick exposure time and the potential interaction with rafting seabirds. However, a relatively low exposure time is needed to compromise a rafting bird.

The modelling predicts that the Shetland Islands are at risk from 'light' shoreline oiling with a maximum thickness of 0.038 mm. The greatest mass of beached condensate at any one location is 3.47 tonnes. Therefore, the seabirds on the shoreline are not at risk from a large scale oiling event.

In summary, the sensitivity of seabirds to a worst case condensate blowout is considered to be **Very High**. The receptor has a <u>Very High value</u>; the seabird assemblage in the vicinity of the Victory field development area is of international importance. Rafting seabirds that are exposed to oiling have very limited tolerance and recovery is unlikely. Therefore, the receptor <u>resistance and resilience is Low</u> to condensate pollution. The magnitude of impact is considered to be **Moderate**, as although modelling predicts an intermittent surface slick, restricted in size (maximum 17 km^2) over a period of 60 days, the area around Victory is important for seabirds. The released condensate does, however, not persist and modelling shows rapid recovery towards baseline conditions in the ten day duration after the blowout cessation. Effects on seabirds due to the worst case blowout scenario are therefore assessed as **Major**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to seabirds from a well blowout is considered to be **Medium**. However, the risk has been reduced to ALARP through mitigation measures and good industry practice (refer to Section 11.6) and is therefore not considered to be significant.

Figure 11.4: Surface Slick Area (with a concentration >100 kg / km²) and Surface Oil Mass over Time during Winter Run No. 67) (Graph A: x-axis scale 0-1,680 hours; Graph B: x-axis scale 0-168 hours (first week of spill scenario))



11.4.7 Marine Mammals

Although marine mammals also use the sea surface in a similar manner to seabirds (refer to Section 11.5.6), they are generally less affected by spills of oil as they can detect and move away from oiled areas (Abbriano *et al*., 2011). Unlike fish or seabirds, oil is also unlikely to adhere to or permeate through the skin of marine mammals where it could accumulate in tissues and have toxicity effects (Neff, 1990). Additionally, marine mammals do not drink large volumes of water, therefore accumulation of oil via this route is unlikely (Neff, 1990). Baleen whales (such as the minke whale) however, frequently filter feed on the water's surface, and therefore would be more likely to ingest oil as they target their prey (Neff, 1990). Marine mammals may also be exposed to toxic volatile fractions as they surface to breathe. Although cetacean mortality as a direct result of contact with condensate is unlikely, there is potential for sub-lethal impacts on individuals.

As discussed in Section 4.3.5, cetacean species most likely to be present in the vicinity of the proposed Victory development include harbour porpoise, killer whale, minke whale, pilot whale, white-beaked dolphin and white-sided dolphin. All species of cetacean are listed as European Protected Species (species of national importance) (listed in Annex IV of the EC Habitats Directive) and the harbour porpoise and bottlenose dolphin are listed under Annex II of the EC Habitats Directive, a status that obliges member states to afford protection to species and habitats through the designation of SACs. There is little documented evidence of cetacean behaviour being affected by hydrocarbon spills. Cetacean sightings before and after the Sea Empress oil spill (harbour porpoise and bottlenose dolphin) in South Wales suggested no change in the frequency or distribution of their occurrence (Edwards and White, 1999).

Both harbour and grey seals are widespread around the west coast of Shetland and Orkney (SCOS, 2019). Seals utilising coastal waters, particularly those at haul-out and breeding sites, may be impacted in the event of shoreline oiling. These species rely on their fur to regulate their body temperature which may be hindered if fur becomes matted with oil and may subsequently suffer from hypo- or hyperthermia. Individuals may also be at risk of ingesting oil when cleaning themselves (ITOPF, 2014b). The modelling predicts that the Shetland Islands are at risk from 'light' shoreline oiling with a maximum thickness of 0.038 mm. The greatest mass of beached condensate at any one location is 3.47 tonnes (over a 1 km section length of coastline). Therefore, the seal haul-out sites on the shoreline are not at risk from a large scale oiling event.

In summary, the sensitivity of marine mammals to a worst case condensate blowout is considered to be **Medium**. The receptor has a Very High value as marine mammals are of international importance. However, the condensate does not persist and marine mammals are highly adaptive and resilient to pressure and are able to avoid hydrocarbon pollution. Therefore, the receptor resistance and resilience is Very High to condensate pollution. The magnitude of impact is considered to be **Minor**; the released condensate does not persist and modelling shows rapid recovery towards baseline conditions in the ten day duration after the blowout cessation. Effects on marine mammals due to the worst case blowout scenario are therefore assessed as **Minor**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to marine mammals from a well blowout is considered to be **Low**.

11.4.8 Marine Protected Areas

The MPAs at risk from surface, shoreline and subsurface oiling are detailed in Appendix B with the maximum probability, shortest arrival time and maximum severity identified for each site per season.

Shoreline Oiling

MPAs located on the Shetland coastline are at risk of low severity 'light' shoreline oiling (refer to Appendix B). Trajectory modelling revealed that up to 39.88 km of coastline could be impacted during the winter with a maximum oiling thickness of 0.038 mm. Furthermore, the greatest mass of beached condensate at any one location is 3.47 tonnes (over a 1 km section length of coastline). Modelling also found that beached condensate does not persist with high evaporation and degradation. During winter lower temperatures inhibit the evaporation rate, however only 0.09 % of released condensate remains on the shoreline after 70 days (i.e. 10 days after the blowout release has ceased). Therefore, the protected features (namely, seabirds and marine mammals) of coastal SPA, SAC and RAMSAR sites are at **Low** risk from a large scale shoreline oiling event (refer to Section 11.4.6 and Section 11.4.7).

Subsurface Oiling

All MPAs at risk from subsurface oil are subject to low severity concentrations (<58 ppb) of condensate (refer to Appendix B). Therefore, mortality to protected fauna is not expected to occur from condensate concentrations in the water column. In addition, condensate does not persist within the water column, with only a small proportion (circa. 2 %) of released condensate remaining within the water column after 70 days. Therefore, the protected subsurface features of MPAs are at **Low** risk from a large scale subsurface oiling event

Surface Oiling

MPAs that are designated for seabirds are particularly vulnerable to surface oiling as detailed in Section 11.4.6. Although modelling predicts the condensate slick does not persist and occupies a maximum area of 17 – 20 km^2 at any one time, a relatively low exposure time is required to compromise protected seabird species. Table 11.9 lists those MPAs which have qualifying features vulnerable to surface oiling and assesses the impact to these sites in the event of a worst case blow out scenario from the Victory development. Of note, is that the probability of surface oil reaching the majority of these sites is relatively low. The Hermaness, Saxa Vord and Valla Field SPA is most at risk from surface oiling with a 25 % probability (refer to Table 11.9 and Appendix B).

In summary, it can be concluded from Table 11.9, that the sensitivity of MPAs to surface oiling from a worst case condensate blowout is **Very High**. The receptor has a Very High value as it is of international importance. The qualifying features (seabirds) have a very limited tolerance to surface oiling and recovery is unlikely; therefore, the resistance and resilience is Low to condensate pollution. The magnitude of impact is considered to be **Major**, as surface oiling could result in mortality to or significant disturbance / displacement of the qualifying features (seabirds), thereby adversely impacting the conservation objectives of the MPAs (refer to Table 11.9). Effects on MPAs due to surface oiling from the worst case blowout scenario are therefore assessed as **Major**. When combined with the likelihood of the event occurring (Extremely Rare), the surface oiling from a worst case blowout scenario presents a **Medium** risk to MPAs. However, the risk has been reduced to ALARP through mitigation measures and good industry practice (refer to Section 11.6) and is therefore not considered to be significant.

Table 11.9: Assessment of MPAs with Qualifying Features at Risk from Surface Oiling

Protected Area	Surface Oil		Protected Features & Conservation Objectives at Risk from Surface Oil	Potential Impact to Conservation Objectives?	Impact Assessment Note 1		
	Probability	Maximum Severity			Sensitivity to Surface Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Seas off Foula SPA	3 - 8 %	BAOAC: 4	**Protected Features:** Great skua *Stercorarius skua* (breeding and non-breeding); assemblage of breeding seabirds; assemblage of seabirds, non-breeding; northern fulmar *Fulmarus glacialis* (breeding and non-breeding); Arctic skua *Stercorarius parasiticus* (breeding); common guillemot *Uria aalge* (breeding and non-breeding); Atlantic puffin *Fratercula arctica* (breeding). **Conservation Objectives:** 1. Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term; 2. Maintain the habitats and food resources of the qualifying features in favourable condition.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Foula SPA	2 – 5 %	BAOAC: 2	**Protected Features:** Arctic skua *Stercorarius parasiticus* (assemblage feature); Arctic tern *Sterna paradisaea* (breeding); Atlantic puffin *Fratercula arctica* (breeding); black-legged kittiwake *Rissa tridactyla* (assemblage feature); common guillemot *Uria aalge* (breeding); European shag *Phalacrocorax aristotelis* (breeding); great skua *Stercorarius skua* (breeding); Leach's storm petrel *Oceanodroma leucorhoa* (breeding); northern fulmar *Fulmarus glacialis* (breeding); razorbill *Alca torda* (assemblage); red-throated diver *Gavia stellate* (breeding); Seabird assemblage, breeding. **Conservation Objectives:** 1. To ensure that the qualifying features of Foula SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status; 2. To ensure that the integrity of Foula SPA is restored in the context of environmental changes by meeting objectives 2a, 2b and 2c for each qualifying feature: a. The populations of the qualifying features are viable components of Foula SPA; b. The distributions of the qualifying features throughout Foula SPA are maintained by avoiding significant disturbance of the species. c. The supporting habitats and processes relevant to qualifying features and their prey/food resources are maintained, or where appropriate restored, at Foula SPA.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Protected Features & Conservation Objectives at Risk from Surface Oil	Potential Impact to Conservation Objectives?	Impact Assessment Note 1		
	Probability	Maximum Severity			Sensitivity to Surface Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Papa Stour SPA	2 – 4 %	BAOAC: 2	**Protected Features:** Arctic tern *Sterna paradisaea* (breeding); ringed plover *Charadrius hiaticula* (breeding). **Conservation Objectives:** To ensure for the qualifying species that the following are maintained in the long term: 1. Population of the species as a viable component of the site; 2. Distribution of the species within site; 3. Distribution and extent of habitats supporting the species; 4. Structure, function and supporting processes of habitats supporting the species; 5. No significant disturbance of the species.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**
East Mainland Coast, Shetland SPA	1 – 2 %	BAOAC: 2	**Protected Features:** Supports populations of great northern diver *Gavia immer*; red-throated diver *Gavia stellate*; Slavonian grebe *Podiceps auritus*. Supports migratory populations of common eider *Somateria mollissima faeroeensis*; long-tailed duck *Clangula hyemalis*; red-breasted merganser *Mergus serrator.* **Conservation Objectives:** 1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, subject to natural change, thus ensuring that the integrity of the site is maintained in the long-term and it continues to make an appropriate contribution to achieving the aims of the Birds Directive for each of the qualifying species. 2. This contribution will be achieved through delivering the following objectives for each of the site's qualifying features: a. Avoid significant mortality, injury and disturbance of the qualifying features, so that the distribution of the species and ability to use the site are maintained in the long-term; b. To maintain the habitats and food resources of the qualifying features in favourable condition.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Protected Features & Conservation Objectives at Risk from Surface Oil	Potential Impact to Conservation Objectives?	Impact Assessment Note 1		
	Probability	Maximum Severity			Sensitivity to Surface Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Bluemull and Colgrave Sounds SPA	1 – 11 %	BAOAC: 2	**Protected Features:** red-throated diver *Gavia stellate* (breeding). **Conservation Objectives:** 1. To ensure that red-throated diver at Bluemull and Colgrave Sounds SPA are in favourable condition and make an appropriate contribution to achieving Favourable Conservation Status. 2. To ensure that the integrity of Bluemull and Colgrave Sounds SPA is maintained in the context of environmental changes by meeting objectives 2a, 2b and 2c for red-throated diver: a. The population of red-throated diver is a viable component of the site. b. The distribution of red-throated diver throughout the site is maintained by avoiding significant disturbance of the species. c. The supporting habitats and processes relevant to red-throated diver and their prey/food resources are maintained.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Fetlar SPA	2 %	BAOAC: 2	**Protected Features:** : Arctic skua *Stercorarius parasiticus* (assemblage); Arctic tern *Sterna paradisaea* (breeding); dunlin *Calidris alpina schinzii* (breeding); fulmar *Fulmarus glacialis* (assemblage); great skua *Stercorarius skua* (breeding); red-necked phalarope *Phalaropus lobatus* (breeding); whimbrel *Numenius phaeopus* (breeding); seabird assemblage, breeding. **Conservation Objectives:** 1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; 2. To ensure for the qualifying species that the following are maintained in the long term: a. Population of the species as a viable component of the site. b. Distribution of the species within site. c. Distribution and extent of habitats supporting the species. d. Structure, function and supporting processes of habitats supporting the species. e. No significant disturbance of the species.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Protected Area	Surface Oil		Protected Features & Conservation Objectives at Risk from Surface Oil	Potential Impact to Conservation Objectives?	Impact Assessment Note 1		
	Probability	Maximum Severity			Sensitivity to Surface Oiling	Magnitude of Oiling Impact	Significance Evaluation (Consequence x Likelihood)
Hermaness, Saxa Vord and Valla Field SPA	6 – 25 %	BAOAC: 4	**Protected Features:** : fulmar *Fulmarus glacialis* (assemblage); gannet *Morus bassana* (breeding); great skua *Stercorarius skua* (breeding); guillemot *Uria aalge* (assemblage); kittiwake *Rissa tridactyla* (breeding); puffin *Fratercula arctica* (breeding); red-throated diver *Gavia stellate* (breeding); shag *Phalacrocorax aristotelis* (assemblage); seabird assemblage. **Conservation Objectives:** 1. To avoid deterioration of the habitats of the qualifying species or significant disturbance to the qualifying species, thus ensuring that the integrity of the site is maintained; 2. To ensure for the qualifying species that the following are maintained in the long term: a. Population of the species as a viable component of the site. b. Distribution of the species within site. c. Distribution and extent of habitats supporting the species. d. Structure, function and supporting processes of habitats supporting the species. e. No significant disturbance of the species.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**
Ronas Hill – North Roe and Tingon RAMSAR	3 – 9 %	BAOAC: 4	**Protected Features:** Species regularly supported during the breeding season: red-throated diver *Gavia stellate*; northern fulmar *Fulmarus glacialis*; whimbrel *Numenius phaeopus islandicus*; Arctic skua *Stercorarius parasiticus*; great skua *Catharacta skua*; black guillemot *Cepphus grille.* **Conservation Objectives:** No information available.	N/A	Very High	Major	Major x Extremely Rare = **MEDIUM**
Fetlar to Haroldswick MPA	1 – 11 %	BAOAC: 2	**Protected Features:** black guillemot *Cepphus grille* (breeding). **Conservation Objectives:** 1. The aim is to conserve protected features in order to make a long lasting contribution to the MPA network.	Yes – mortality and disturbance to protected features.	Very High	Major	Major x Extremely Rare = **MEDIUM**

Note 1: Refer to Section 5.3 for impact assessment methodology.

11.4.9 Socio-economic Receptors

Commercial Fisheries

Major oil spills can have a serious impact on commercial fishing activities through physical contamination of fish, oiling of fishing boats and gear and loss of access to fishing grounds as well as market confidence (ITOPF, 2014c).

The area in the vicinity of the proposed Victory development is known to be heavily fished, by both Scottish and international vessels, with effort dominated by trawlers. VMS data indicates that Victory is located within an area of high demersal fishing effort, targeting species including saithe, monkfish, cod, ling and haddock. The pelagic (mackerel and herring) fishing effort is low to medium in the vicinity of the proposed Victory development; occurring at higher intensity towards the south and east, closer to shore (see Section 4.4.1).

Modelling predicts that water column oiling at a concentration (>10 ppb) that causes fish tainting could occur up to 73 km from the Victory release location. However, mass mortality of commercial fish species is not predicted. Lethal exposure concentrations (>58 ppb) are limited to 8 km from the release location and the condensate does not persist in the water column for any length of time (refer to Section 11.5.1). Throughout the spill duration, surface oiling could displace fishing vessels from the region; however, modelling predicts the condensate slick will cover a relatively small area at any one time (17 – 20 km^2). Furthermore, surface oiling does not persist, with zero surface oil predicted 10 days after the cessation of the blowout release.

In summary, the sensitivity of commercial fisheries to a worst case blowout is considered to be **High**. The receptor has a Very High value as the area in the vicinity of the Victory field is heavily fished, both by UK and international vessels. However, the condensate does not persist and potentially lethal exposure concentrations of hydrocarbons are limited to within 8 km of the release location. Therefore, receptor resistance and resilience is High to condensate pollution, particularly given the alternative fishing ground in the wider area. The magnitude of impact is considered to be **Minor**, as the released condensate does not persist and modelling shows rapid recovery towards baseline conditions in the ten day duration after the blowout cessation. Effects on commercial fisheries due to the worst case blowout scenario are therefore assessed as **Minor**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to commercial fisheries from a well blowout is considered to be **Low**.

Mariculture

Mariculture is a prominent industry along the west coast of the Shetland Islands located in the inshore areas (Baxter et al., 2011; Scotland's Aquaculture, 2021). As discussed in Section 4.4.1, Shetland produces approximately 18 % of the total Scottish salmon and 79 % of the farmed mussels), although small volumes of oysters and scallops have also been produced in the past (Marine Scotland, 2021b). Mariculture sites are vulnerable to the effects of oiling. However, the modelling predicts that the inshore areas of Shetland will not be exposed to harmful concentrations of subsurface oil (refer to Section 11.2.1 and Appendix B). As demonstrated in Figure 11.3, mariculture sites located along the west coast of Shetland are not at risk from fish tainting. Inshore areas of Shetland may be exposed to BAOAC 4 surface oiling. However, as detailed in Section 11.4.2, the surface condensate is not predicted to persist with zero surface oil predicted 10 days after the cessation of the blowout release.

In summary, the sensitivity of mariculture to a worst case blowout is considered to be **High**. The receptor has a Medium value; the mariculture is of regional importance. Mariculture sites are vulnerable to oiling exposure as the farmed fish / shellfish are unable to avoid or more away from pollution; therefore, the receptor resistance and resilience is Low to condensate pollution. The magnitude of impact is considered to be **Minor**, as the worst case oil spill modelling revealed that inshore areas of Shetland will not be exposed to harmful concentrations of subsurface oil and any surface condensate is not predicted to persist with zero surface oil predicted 10 days after the cessation of the blowout release. Effects on mariculture due to the worst case blowout scenario are therefore assessed as **Minor**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to mariculture from a well blowout is considered to be **Low**.

Recreational Activity and Tourism

In coastal areas there can be high economic costs associated with oil spills, due to the clean-up operations involved, as well as financial losses to industry sectors that rely on clean seawater and clean coastal areas, such as the tourism industry (ITOPF, 2014c). The smell and appearance of stranded oil may be a nuisance to people living on the affected shoreline.

Tourism and leisure activities are focussed along the coastline and nearshore water of the Shetland Islands. Coastal tourism activities include wildlife watching for birds, otters, cetaceans and pinnipeds, as well as recreational and sport fishing activities. Scuba diving is also popular due to the extensive rocky shores and kelp beds which support a diverse assemblage of species (DTI, 2005; Visit Shetland, 2021).

Following a worst case release of condensate, areas with the highest probability of shoreline contamination in Shetland include the Unst (28 %), Yell (27 %) and mainland (22 %) coastlines. Other locations that make up the Shetland Islands (Foula, Papa Story, Out Skerries, Fetlar, Muckle Row, Scalloway Islands, Bressay, Vaila and Vementry) have probabilities of less than 10 %. However, shoreline oiling at all locations is predicted to be of low severity (maximum thickness 0.038 mm) and will not persist (refer to Section 11.4.2 and Appendix B).

In summary, the sensitivity of recreational activity and tourism to a worst case blowout is considered to be **Low**. The receptor has a High value; recreational activity and tourism is of importance to the local economy. However, the condensate does not persist with recreational activity and tourism expected to recovery in the short term; therefore, the receptor resistance and resilience is very high to condensate pollution. The magnitude of impact is considered to be **Minor**, as the released condensate does not persist and modelling shows rapid recovery towards baseline conditions in the ten day duration after the blowout cessation. Effects on recreational activity and tourism due to the worst case blowout scenario are therefore assessed as **Minor**. When combined with the likelihood of the event occurring (Extremely Rare), the risk to recreational activity and tourism from a well blowout is considered to be **Low**.

11.5 Potential for a Major Environmental Incident

A MEI is defined as "*an incident which results, or is likely to result, in significant adverse effects on the environment in accordance with Directive 2004/35/EC of the European Parliament and the of the Council on environmental liability with regard to the prevention and remedying of environmental damage*".

Under Directive 2004/35/EC, "*environmental damage*" is defined as:

- *"Damage to protected species and natural habitats, which is any damage that has significant adverse effects on reaching or maintaining the favourable conservation status of such habitats or species. The significance of such effects is to be assessed with reference to the baseline condition, taking account of the criteria set out in Annex I";*
- *"Water damage, which is any damage that significantly adversely affects the ecological, chemical and/or quantitative status and/or ecological potential, as defined in Directive 2000/60/EC, of the waters concerned, with the exception of adverse effects where Article 4(7) of that Directive applies";*
- *"Land damage, which is any land contamination that creates a significant risk of human health being adversely affected as a result of the direct or indirect introduction, in, on or under land, of substances, preparations, organisms or micro-organisms".*

For an event to be considered as a MEI, a major accident (as defined under SCR 2015) must be a precursor (BEIS, 2017). For the proposed Victory development, the major accident scenario that would result in the worst case release of hydrocarbons is:

- Loss of well control and subsequent blowout that can only be stopped by drilling a relief well.

Based on the results of the oil spill modelling (Section 11.3.2 and Appendix B) and the assessment of environmental and socio-economic effects as detailed in Section 11.4, it is considered possible that surface oiling from a worst case release of hydrocarbons could significantly impact ecosystems (i.e.

there could be a significant adverse impact on the favourable conservation status of relevant species and/or habitats in areas identified to be at risk from oiling); these impacts would likely constitute a MEI.

As discussed in Sections 11.4.6 and 11.4.8, it is the severity of surface oiling that presents the greatest risk to Annex I habitats, Annex II/IV species and MPA features. MPAs that are designated for seabirds are particularly vulnerable to surface oiling. As detailed in Table 11.9, the MPA protected features (i.e. seabirds) for 7 x SPAs, 1 x RAMSAR site and 1 x NC MPA are at risk from a severity of surface oiling that would constitute a MEI. Conversely, as discussed in Section 11.4.8, the severity of shoreline and subsurface oiling from a worst case blowout scenario is unlikely to cause impacts that would constitute a MEI.

It should be stressed that the identified major accident scenario is an extreme worst case; it assumes the complete failure of all control and preventative measures. In a real situation, steps would immediately be taken to stem the flow of hydrocarbons and in the event of a well control incident bring the well back under control (refer to Section 11.6).

11.6 Mitigation Measures

11.6.1 Spill Prevention Measures

It is the policy of Corallian that the Victory field development will be designed and operations will be conducted in such a manner as to minimise the risk of accidental releases. Onshore design reviews, risk assessments and operations planning are used to identify potential risks and to ensure that, where possible, risks are minimised at the design stage. Where residual risks remain, mitigation procedures will be put in place to prevent accidental spills as summarised in Table 11.10. These take into account relevant learnings from both the Montara and Macondo well control incidents.

MODU and vessel contractors will be required to demonstrate that they have control processes in place to minimise environmental impacts. Training, competency and maintenance of safety and environmentally critical equipment all play vital roles in ensuring the risks of pollution are as low as reasonably practicable.

An approved OPEP will be in place, prepared in advance of activities commencing offshore, which will detail the spill prevention measures, response procedures and resources available to Corallian in the event of a spill. All supporting vessels will also have a ship oil pollution emergency plan (SOPEP) onboard.

Table 11.10: Spill Prevention Measures for the Victory Development

Source	Spill Prevention Measures
Loss of chemicals, fuel or utility hydrocarbons during bunkering and general operations	• Liquid storage areas and areas that might be contaminated with oil are segregated from other deck areas; • Permanent drip trays will be located under process plant, pumps and vessels (on grated decks); • Bunding or additional containment will be provided around plated areas beneath equipment with significant hydrocarbon inventories; • Chemicals will be stored in bunded areas where any spillages can be routed to the closed drainage system; • Chemical, utility and fuel storage tanks will be equipped with alarm systems and procedure will be in place to minimise and prevent spills overfilling these storage tanks; • Small spill kits will be on board the MODU to clean up deck spills and prevent spilt hydrocarbons and chemicals from reaching the sea; • Non-return valves will be installed on transfer hoses and hoses to be tested and inspected as a part of a regular maintenance programme; • Bunkering procedures will be put in place to include measures such as transfer operations to be supervised at all times from both the supply vessel and MODU;

Source	Spill Prevention Measures
	• Crews will be adequately trained, supervised and regular exercises held to contain and clean-up deck spills; • Routine equipment maintenance programme will be in place with specific emphasis on environmentally critical equipment; • Effective management of chemicals to endeavour to reduce the volumes required and therefore the frequency of bunkering; • Use of floating hoses; • Where feasible, bunkering operations will be undertaken in daylight and in good weather conditions.
Loss of containment on MODU due to collision or other major event	• Consent to Locate will be in place for the MODU under Part 4A of the Energy Act 2008; • 500m safety exclusion zone will be designated around the MODU; • Dedicated ERRV present during drilling to monitor movements of other vessels in the area and prevent them entering the exclusion zones; • Notifications made to 'regular runners' and local fisheries organisations via Notices to Mariners, NAVTEX / NAVAREA warnings and fisheries notices.
Well Blowout	• Undertake shallow gas survey prior to drilling; • Crews will be adequately experienced, trained in well control techniques and supervised; • Weighted drilling fluids will provide the primary barrier and the downhole pressures will be carefully controlled and monitored; • The secondary barrier will be the BOP which will be regularly maintained and tested; • Well design and construction reviewed by an independent well examiner; • Safety and Environmental critical elements related to drilling operations will be identified, and a suitable maintenance and testing schedule applied to each; • Emergency drills will be held regularly; • Emergency response plans and equipment will be in place; • Review spill mitigation measures of all contractors as part of the contractor selection process.
Loss of pipeline, flowline or umbilicals	• Facilities will be subject to stringent design specifications; • Pressure and leak testing will be undertaken onshore prior to infrastructure being installed and all pipelines, flowlines and risers pressure tested to above the planned operating pressure; • The pipeline will be protected against corrosion by the continuous injection of corrosion inhibitor, supplied as a cocktail with the hydrate inhibitor at the subsea xmas tree. • The pipeline and umbilical will protected from physical damage by fishing gear or anchors by rock protection ; • Routine monitoring of pipeline pressure and temperature will be undertaken. Automatic and manual shutdown systems in place; • Regular ROV inspection of all pipelines will be undertaken.

11.6.2 Oil Spill Response Strategy

With respect to accidental spills, the greatest importance lies with preventing their occurrence in the first instance. However, in the unlikely event of a spill incident occurring, a suitable response strategy must be in place to manage and control a spill.

Response Options

Based on a review of data within OGUK's Oil Spill Response Effectiveness in UK Waters Guidelines (April 2015), the only viable response options available to Corallian for the Victory development, given the type of hydrocarbons that would be released (i.e. ITOPF Group 1), are as follows (see Figure 11.5):

- **Natural Dispersion**: the natural processes by which the condensate reacts to when in the environment;
- **Monitor and Evaluate:** monitoring the fate of the oil and quantifying the size of the slick.

Given the nature of these response options, a 100 % response effectiveness is therefore available throughout the year.

Corallian will ensure that a contract is in place with an established oil spill response contractor, prior to commencing field development operations offshore. The oil spill response contractor will be able to provide aerial surveillance, if required in the event of an incident. This is the method of choice for observing and monitoring oil spills in the field as it allows visibility over a wide area. Aerial surveillance can be supplemented with the use of satellite imagery and real-time oil spill modelling, both of which can be mobilised through the oil spill response contractor.

Figure 11.5: Response Options for ITOPF Group 1 Oils in the Faroe / Shetland Channel

	Aerial Dispersant	In-situ Burn	Monitor & Evaluate	Natural Dispersion
Wind Speed	N/A Aerial dispersant is not an option for Non-Persistent Group 1 oil as it will naturally disperse	N/A In-situ burning is not an option for Non-Persistent Group 1 oil as it will naturally disperse	**Between 0 kts & 45 kts**	**All wind speeds**
Visibility			Does not affect Response	Does not affect Response
Precipitation			Does not affect Response	Does not affect Response
Temperature			Does not affect Response	Does not affect Response
Tidal State			Does not affect Response	Does not affect Response
Current Speed			Does not affect Response	Does not affect Response
Ice & Debris			N/A in UK Climate	N/A in UK Climate
Daylight			**Available 24 hrs**	Does not affect Response
Wave Height			Does not affect Response	**All wave heights**

	Contain and Recover	Shoreline Response	Vessel Dispersant
Wind Speed Visibility Precipitation Temperature Tidal State Current Speed Ice & Debris Daylight Wave Height	N/A Containment and recovery is not an option for Non-Persistent Group 1 oil as it will naturally disperse	N/A Shoreline response is not an option for Non-Persistent Group 1 oil as it is unlikely to make landfall.	N/A Vessel dispersant is not an option for Non-Persistent Group 1 oil as it will naturally disperse

Source Control Options

In the event of a well control incident, source control will be prioritised, where possible, to stop the flow as quickly as possible in a manner that does not expose the environment to an extended release of hydrocarbons. If primary and secondary well control is lost by way of a blowout and oil flows uncontrollably from the well to the marine environment, then deployment of a capping device and / or a relief well may be required to stop the flow and bring the well under control.

Corallian estimate that it would take 60 days to drill a relief well; this is worst case and includes time to survey the proposed relief well drilling location and source and mobilise a suitable drilling rig. Note, as the Victory development well is not a high pressure/high temperature well and is not being drilled in deep water, it is not anticipated that a specialist drilling rig configuration would be required and a standard semi-submersible or drill ship would be suitable to drill a relief well.

11.7 Residual Risk

Based on historical data and taking into account the spill prevention measures that will be in place, the most probable accidental releases from the proposed Victory development will be small in volume. It is considered to be extremely rare for a major event, such as a blowout, to occur, particularly given the measures that will be in place to reduce the probability of a failure of well control. The consequences of an accidental release from the Victory development will vary depending on the quantity and type of oil or chemical spilt, the wind speed and direction and sea state and the sensitivity of receptors depending on the time of year. A small spill of condensate, diesel or chemicals would be subject to rapid dilution and dispersion and any impact on receptors in the marine environment would be short term and localised.

The Victory condensate is an ITOPF Group 1 (85° API) which is subject to rapid evaporation and biodegradation rates upon release. The condensate does not persist in the water column, on the sea surface or at the shoreline. The residual risk to the marine environment from a worst case accidental release is considered to range from **Medium** to **Low**, depending on the receptor impacted, but in all cases the risk has been reduced to ALARP through mitigation measures and good industry practice and is therefore not considered to be significant.

11.8 Transboundary Impacts

The modelling predicts a very low probability of surface oil crossing the Norwegian (5 – 9 %) and Faroe Islands (1 – 5 %) median lines (refer to Table 11.6). Norwegian waters may experience BAOAC 3 – Metallic coloured oiling and Faroe Islands waters may experience BAOAC 2 – Rainbow coloured oiling. The minimum time for surface oil to reach the Norwegian and Faroe Islands median lines is 135 hours and 119 hours, respectively. In addition, there is a very low probability (1 %) that shoreline oiling could occur on the Norwegian coastline during winter. However, it is important to note that the scenario modelled is an extreme worst case; it assumes the complete failure of all control and preventative measures. In a real situation, steps would immediately be taken to stem the flow of hydrocarbons and bring the well back under control. A counter-pollution response strategy would also be developed and initiated. Given the mitigation measures that would be in place the risk of transboundary impacts is considered to be **Low** and not significant.

In the event of an oil spill entering Norwegian waters it may be necessary to implement the NORBRIT Agreement (the Norway-UK Joint Contingency Plan). The NORBRIT Agreement sets out command and control procedures for pollution incidents likely to affect both parties, as well as channels of communication and resources available. The Agreement is largely oriented towards major spills; however, it is not confined to such events and will apply as necessary to any spills within the NORBRIT regions, which are of sufficient severity to warrant joint action. The NORBRIT Agreement becomes operational when agreement to the request for its implementation is reached. Responsibility for implementing joint action rests with the Action Co-ordinating Authority (ACA) of the country on whose side of the median line a spill originated. In this case, Corallian would immediately inform the MCA (and BEIS) once they have any indication that an oil spill will encroach into Norwegian waters. The MCA would assume the role of the ACA and request Norwegian resources if required.

A Local Agreement of Mutual Support also exists between the UK and the Faroe Islands, with regards to spill preparedness and response.

11.9 Cumulative Impacts

Cumulative effects from accidental releases are not anticipated. Any impact to the marine environment from a small hydrocarbon spill would be short term and localised. The probability of a major hydrocarbon release occurring from the proposed Victory development is extremely rare given the mitigation measures that will be in place.

12 Environmental Management

12.1 Introduction

The identification and control of potential environmental impacts associated with all Corallian's activities forms an integral part of managing the business. Impacts are identified during the planning stages of all operations and the risks evaluated and managed through an integrated Health, Safety and Environmental Management System (HSE MS). This system provides the structured management framework within which environmental impacts are identified, assessed, controlled, and monitored.

As the offshore licensee, Corallian is responsible for the Victory Development during all lifecycle phases of the project.

Corallian is planning to appoint a well operator and a pipeline operator, subject to approval by the NSTA under The Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015. The appointed well operator will manage the development drilling and well completion operations, as well as any future well intervention (maintenance) and subsequent well abandonment operations. The appointed pipeline operator will manage any pipeline interventions once the field goes into production and subsequent pipeline abandonment activities.

The appointed entities will be subject to a capability assessment which will include checking that the entities have the technical and managerial ability to do the job, as well as being adequately resourced, both financially and in having sufficient numbers of competent staff. With regards to the well activities, Corallian will ensure that the appointed well operator is capable of satisfactorily carrying out the functions and discharging the duties of an operator as defined in The Offshore Installations (Offshore Safety Directive) (Safety Case etc.) Regulations 2015.

Corallian will ensure that the activities comply with the OSPAR Recommendation 2003/5 to Promote the Use and Implementation of Environmental Management Systems by the Offshore Industry. Corallian will also monitor and evaluate the performance of the contractors, either directly or via the appointed operators, particularly with respect to safety and environmental performance.

As part of the Victory Development, Corallian will also interact closely with TotalEnergies, the operator of the GLA infrastructure.

The remainder of this section describes the main components of the Corallian HSE MS, how it will be integrated with the management systems of other entities and explains how the potential impacts identified within this ES will be managed throughout the proposed Victory development operations.

12.2 Corallian EHS MS

12.2.1 HSE Policy

Corallian's Health, Safety and Environmental (HSE) Policy defines and documents the Company's commitment to the health and safety of individuals, integrity of company property and the protection of the environment (refer to Figure 12.1).

The implementation of the HSE Policy is achieved through application of Corallian's HSE MS. Achieving the policy goals depends on the commitment of everybody who works for Corallian, including contractors, suppliers and consultants. It is therefore the responsibility of everyone to ensure that the system is understood and followed.

Corallian's HSE Policy is regularly reviewed and, if necessary, modified and revisited following any material changes in the company. It is made available to the public and those working for and on behalf of Corallian as necessary.

Figure 12.1: HSE Policy Statement

Corallian Energy

HEALTH, SAFETY AND ENVIRONMENTAL POLICY STATEMENT

Corallian wishes to build value through developing sustainable long-term relationships with partners and the community.

We will, as a minimum, comply with all applicable legislation; and design and manage our activities to prevent pollution, minimise environmental and health impacts and provide work places free of safety hazards.

The company is committed to high standards of health, safety and environmental protection; these aspects command equal prominence with other business considerations in the decision-making process.

Health, safety and environmental protection are responsibilities shared by everyone working for the company and the full support of all staff, partners and contractors is vital to the successful implementation of this Policy.

We will ensure, as far as reasonably practicable, that all staff, partners and contractors are aware of their delegated health, safety and environmental responsibilities and are properly trained to undertake these.

We will strive for continuous improvement in our HSE performance and measure this by setting objectives and targets consistent with the aims of this policy.

HSE performance will be routinely monitored and reported regularly to the Board of Directors of the Company, who will ensure that the necessary resources are provided to support this Policy fully.

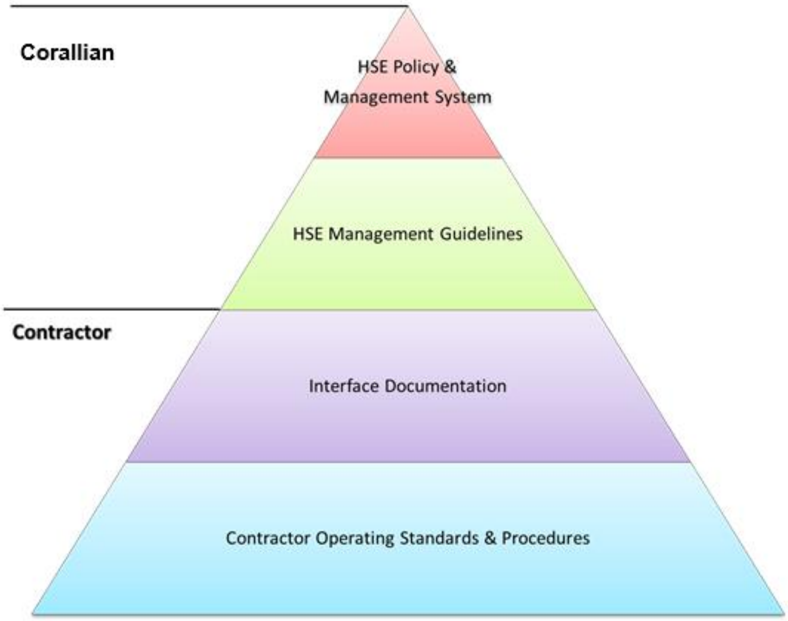
Donal O'Driscoll
Managing Director
November 2021

12.2.2 HSE MS

Corallian's HSE MS is designed to fit the Company's business model. It provides an overview of Corallian's HSE expectations within which all operations will be managed. In most cases, detailed procedures and work instructions will be provided by contractors. This is illustrated in Figure 12.2 and shows:

- The top tier of the HSE MS outlines the core management system and provides the core expectations and requirements;
- The second tier provides guidance on how Corallian can make sure these expectations are being met;
- Each contractor is responsible for managing activities within their HSE MS. When appropriate, contractors' HSE systems and procedures are linked to the Corallian's HSE MS and the appointed operators' management system through interface documents. These define the division of responsibilities between Corallian and its primary contractors.

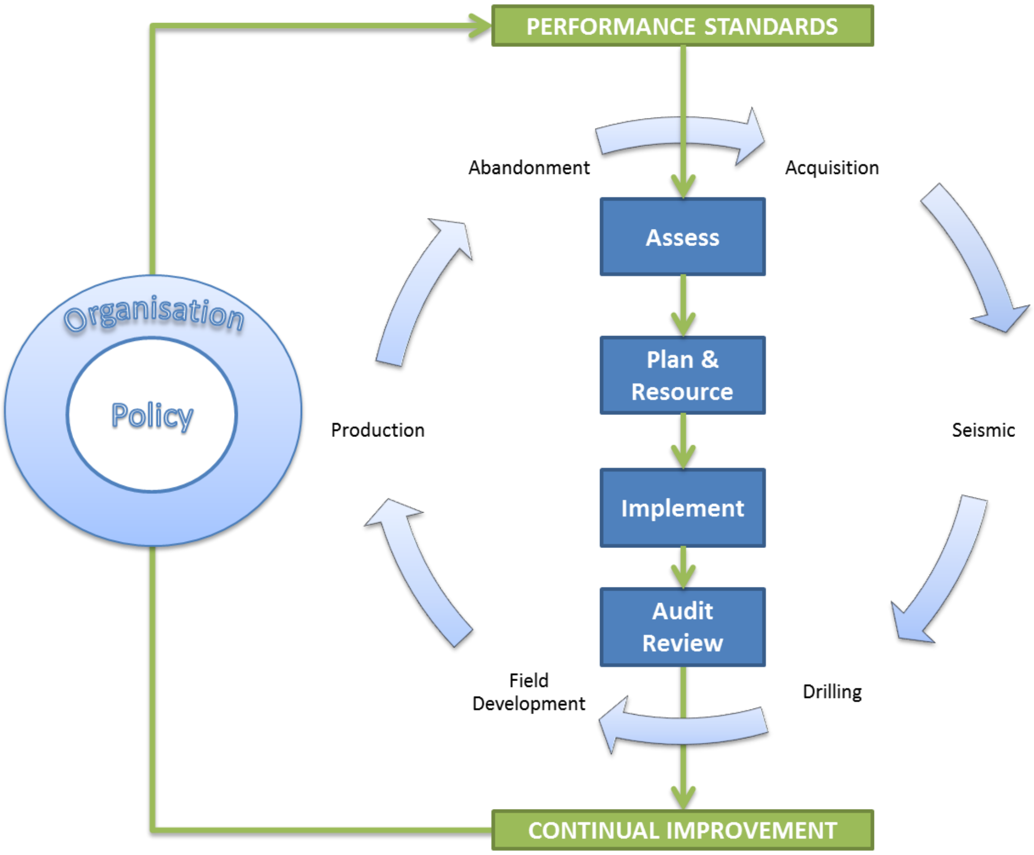
Figure 12.2: Hierarchical Structure of HSE System and Relationship with Contractors



Corallian's HSE MS forms an integral part of its overall management system and is illustrated in Figure 12.3. It is structured around the Plan - Do - Check – Act cycle, typical of internationally accepted management systems, with a feedback loop to facilitate continual improvement in performance.

The energy to drive and maintain the system is provided by the organisation which sets the Company's HSE policy and goals and determines the overall performance standards. The process of applying these standards to each activity within the business starts with an assessment to identify possible hazards, assess the risks and agree sensible controls that will minimise any adverse consequences and reduce risks to levels that are as low as reasonably practicable (ALARP). These measures are then incorporated into work plans and the plans are resourced. Finally, the plans are implemented and the whole process monitored and reviewed to determine overall performance and identify areas where improvements would be worthwhile.

Figure 12.3: HSE MS Process



The HSE MS is dynamic. Although the illustration above shows a defined sequence of events, the system elements operate across the business and at various levels within the organisation and therefore may not strictly follow the sequence shown.

12.2.3 HSE Compliance

The Board of Directors ensures that all legislative requirements and applicable standards are identified for each activity and documented within a project specific legislation register. The Directors also ensure that these requirements are fully implemented and any approvals or permit requirements are incorporated into activity work plans. Assistance and support for this activity is provided by the HSE Representative, the appointed operators and the contractors for specific operations.

The HSE standards adopted by Corallian are those specified in the relevant legislation, codes of practice and guidance notes, together with those contained in recognised industry standards and practices. Applicable standards are generally defined within Contractor Operating Procedures.

Although Corallian does not anticipate being the "operator" for drilling wells or the installation of pipelines and other subsea equipment, the Directors and advisors to the company have experience of such operational activity in the UK and internationally in senior positions. The team are also aware of the safety and environmental requirements for exploration and production activities. It is anticipated that a full time HSE Manager will be appointed by Corallian during the FEED stage of the project and certainly before installation / commissioning operations begin.

12.2.4 Contractor Selection

Contractors will be used throughout the proposed Victory development operations. The Corallian HSE MS includes a requirement to assess HSE capability and performance as an integral part of the contractor selection process. The selection process is dependent on the HSE risks associated with each contract and include:

- Ensuring an effective health, safety and environmental management system is in place;

- Reviewing HSE Performance;
- Reviews of regulatory compliance and inspections;
- Ensuring contractors operate an effective competence system;
- Reviewing audit findings and action tracking;
- Maintenance management (where appropriate);
- Review of previous audit reports (certification, internal, external) and outstanding actions;
- Undertaking or commissioning pre-contract health, safety and environmental audits.

Every effort is made to select contractors with strong HSE performance and processes.

12.2.5 Contractor Management

HSE MS Interface/Bridging Documents will be produced which describe how the various parties will work together in the execution of this project. It will document clear lines of communications and responsibilities between Corallian, the appointed operators and the various contractors throughout the proposed operations, including designation of responsibilities for environmental management and regulatory compliance.

Steps will be taken to ensure that all parties engaged in the proposed Victory operations understand the potential environmental impacts and commitments as outlined in this ES and the importance of environmental compliance. This will be achieved through meetings prior to the commencement of operations and inductions. Oil spill training and exercises will also be undertaken as defined within the future Oil Pollution Emergency Plan (OPEP) for the Victory well.

12.2.6 Audit, Monitoring and Reporting

Environmental audits of the drilling rig and the main subsea installation vessels will be carried out prior to Corallian accepting the vessels for the Victory development activities. Further environmental audits may be conducted during the proposed work programme.

In addition, contractor safety and environmental related performance will be monitored and reviewed throughout the proposed operations, with emissions and discharges monitored and reported in accordance with the HSE MS Interface/Bridging Document. All environmental incidents will be subject to joint investigation and dual reporting.

All environmental emissions data recorded during the proposed Victory operations will be submitted to OPRED via the dedicated Environmental Emissions Monitoring System (EEMS). This includes data on the following:

- Atmospheric emissions;
- Chemicals;
- Drill fluids;
- OPPC returns;
- Waste.

12.3 ES Commitments

Table 12.1 summarises the mitigation measures and commitments identified within this ES. As described above, Corallian will ensure these are taken into account and implemented as the proposed Victory field development project progresses.

Table 12.1: Mitigation Measures and Commitments Register

Ref	Theme	Mitigation Measure / Commitment	ES Section
1	Physical Presence	a. A 500 m safety exclusion zone will be designated around the MODU and a dedicated ERRV will be present during the proposed drilling operations to monitor movements of other vessels in the area and prevent them entering the exclusion zone. b. A full collision risk assessment will be undertaken by Corallian to inform the CtL permit applications, required to site the MODU and subsea infrastructure at the Victory location. c. Information on the location of the MODU and associated anchor pattern, 500 m safety zone, subsea infrastructure and vessel operations, including those involved in pipelay activities, will be communicated to other sea users (via the United Kingdom Hydrographic Office) through the standard communication channels including Kingfisher, Notice to Mariners and Radio Navigation Warnings. d. Corallian will continue to consult with SFF during the detailed design phase and planning process for the subsea infrastructure installation activities and an onshore FLO will be appointed to maintain good communication with local fisheries and co-ordinate activities, particularly when installation the pipeline and umbilical. e. Vessels involved in subsea infrastructure installation operations will update their marks, lights and navigational status broadcast on AIS to indicate when they are restricted in manoeuvrability. f. Up to three guard vessels (each patrolling a stretch of up to ca. 10 km in length) will be present on site during the pipeline and umbilical installation activities, prior to the deposit of protection (rock) on top of the lines, to ensure that other sea users are aware of the ongoing operations. g. Once installed, the subsea infrastructure and the Victory 500 m safety zone will be marked as hazards on admiralty charts and entered into the FishSafe system so they can be avoided by fishing vessels. h. Maintenance inspection surveys will be undertaken throughout the life of the Victory field to ensure the seabed infrastructure and associated protection material remain in a favourable condition.	6

Ref	Theme	Mitigation Measure / Commitment	ES Section
2	Seabed Disturbance	a. Corallian commit to acquire further environmental data along the chosen pipeline and umbilical routes, as required, during the detailed engineering surveys scheduled to be undertaken in 2023. b. During the detailed design phase of the project, use of a weighted pipeline will be investigated, which may reduce the worst case quantity of rock to be deposited. c. The minimum appropriate number of MODU anchors and length of anchor chains will be used to maintain stability and integrity. d. Drill cuttings to be passed through the cuttings cleaning system on the MODU prior to discharge. e. A ROV and chemical dye will be used to monitor cement returns when cementing the 30 inch conductor to help ensure the volume of cement discharged to the seabed is kept at a minimum. f. Working corridors will be minimised, as far as possible. g. Any boulders removed from the pipeline and umbilical lay corridors will be placed appropriately on the seabed to avoid a snag hazard and their as-left position recorded. h. To minimise disturbance to the sand waves features at the Victory location, it is proposed to lay the pipeline in the trough of the mega ripples, where possible; which is aided by the orientation of the sand waves. i. The amount of deposited material will be minimised whilst still achieving the required level of stabilisation / protection. j. Disturbance of the existing protection (rock berm) over the HTT2 structure and Edradour manifold will be minimised, as far as practicable. k. The integrity of subsea infrastructure, including the pipeline / umbilical and stabilisation material, will be monitored throughout production operations and remedial action taken, if required.	7
3	Noise	a. The minimum diameter piles necessary will be used for the subsea structures to achieve structural integrity. b. The JNCC protocol for minimising the risk of injury to marine mammals from piling noise (JNCC, 2010b) will be adhered to, including: • Use of properly qualified, trained and equipped marine mammal observers (MMOs) to detect marine mammals within a "mitigation zone" and potentially recommend a delay to piling operations. The mitigation zone will be at least 500 m. MMOs will carry out a 30 minute pre-piling survey and if an animal is detected then work should be delayed until it has left the area; • Soft-start of piling, whereby there is an incremental increase in power and, therefore, sound level. This should be carried out over a minimum period of 20 minutes. This is believed to allow any marine mammals to move away from the piling location and reduce the likelihood of exposing the animal to sounds which can cause injury; • Repeat of the pre-piling survey and soft-start whenever there is a break in piling of more than 10 minutes; and • Avoiding commencing piling at night or in poor visibility when marine mammals cannot reliably be detected. c. Where possible, piling operations will be timed to avoid periods of high sensitivity for marine mammals and fish. d. During the detailed design phase of the project, Corallian will review the possibility of using an alternative foundation design for the WHPS, pigging skid and tie-in / protection structures in order to reduce the noise impact footprint.	8

Ref	Theme	Mitigation Measure / Commitment	ES Section
4	Atmospheric Emissions	a. Vessel use will be optimised by minimising the number of vessels required, the length of time vessels are on site and mobilisation and demobilisation distances, as far as practicable. This will be managed via a vessel management plan. b. Where possible, activities will be scheduled to minimise waiting on weather. c. Opportunities to share supply boats with nearby operators will be explored to minimise vessel trips. d. Supplier's environmental footprints will be factored into the tender evaluation process. e. Vessels will be operated, where possible, in modes that allow for economical fuel use. f. Combustion equipment on the MODU shall be appropriately maintained to ensure emissions are minimised, as far as practicable. g. The well test and well clean-up activities will be designed not only to achieve their goals but to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely. h. The use of 'green cement' will also be considered (cement which has been manufactured using techniques which minimise CO_2 emissions). i. Procedures will be in place in order to reduce flaring at the SGP during maintenance operations, process upset conditions, system depressurisation and start-up.	9
5	Marine Discharges	a. A chemical risk assessment will be undertaken to identify the risk profile of chemicals being used and / or discharged in accordance with the requirements of the Offshore Chemicals Regulations 2002 (as amended) and, as part of chemical selection and assessment process, less hazardous alternatives will be sought in preference for any chemicals identified to be high risk (e.g. those with substitution warnings). b. Chemical use and discharge will be minimised to as low as practically possible. c. WBM will be mixed offshore to ensure that only what is required is used and recovered WBM will be reused / re-circulated, where practical. d. Any discharges of residual reservoir hydrocarbons will be treated to meet oil-in-water limits of less than or equal to 30 mg/l.	10

6	Accidental Discharges	a. Liquid storage areas and areas that might be contaminated with oil are segregated from other deck areas; b. Permanent drip trays will be located under process plant, pumps and vessels (on grated decks); c. Bunding or additional containment will be provided around plated areas beneath equipment with significant hydrocarbon inventories; d. Chemicals will be stored in bunded areas where any spillages can be routed to the closed drainage system; e. Chemical, utility and fuel storage tanks will be equipped with alarm systems and procedure will be in place to minimise and prevent spills overfilling these storage tanks; f. Small spill kits will be on board the MODU to clean up deck spills and prevent spilt hydrocarbons and chemicals from reaching the sea; g. Non-return valves will be installed on transfer hoses and hoses to be tested and inspected as a part of a regular maintenance programme; h. Bunkering procedures will be put in place to include measures such as transfer operations to be supervised at all times from both the supply vessel and MODU; i. Crews will be adequately trained, supervised and regular exercises held to contain and clean-up deck spills; j. Routine equipment maintenance programme will be in place with specific emphasis on environmentally critical equipment; k. Effective management of chemicals to endeavour to reduce the volumes required and therefore the frequency of bunkering; l. Use of floating hoses; m. Where feasible, bunkering operations will be undertaken in daylight and in good weather conditions; n. 500m safety exclusion zone will be designated around the MODU; o. Dedicated ERRV present during drilling to monitor movements of other vessels in the area and prevent them entering the exclusion zones; p. Notifications made to ‘regular runners’ and local fisheries organisations via Notices to Mariners, NAVTEX / NAVAREA warnings and fisheries notices; q. Undertake shallow gas survey prior to drilling; r. Crews will be adequately experienced, trained in well control techniques and supervised; s. Weighted drilling fluids will provide the primary barrier and the downhole pressures will be carefully controlled and monitored; t. The secondary barrier will be the BOP which will be regularly maintained and tested; u. Well design and construction reviewed by an independent well examiner; v. Safety and Environmental critical elements related to drilling operations will be identified, and a suitable maintenance and testing schedule applied to each; w. Emergency drills will be held regularly; x. Emergency response plans and equipment will be in place; y. Review spill mitigation measures of all contractors as part of the contractor selection process; z. Facilities will be subject to stringent design specifications; aa. Pressure and leak testing will be undertaken onshore prior to infrastructure being installed and all pipelines, flowlines and risers pressure tested to above the planned operating pressure;	11

Ref	Theme	Mitigation Measure / Commitment	ES Section
		bb. The pipeline will be protected against corrosion by the continuous injection of corrosion inhibitor, supplied as a cocktail with the hydrate inhibitor at the subsea Xmas tree; cc. The pipeline and umbilical will protected from physical damage by fishing gear or anchors by rock protection ; dd. Routine monitoring of pipeline pressure and temperature will be undertaken. Automatic and manual shutdown systems in place; ee. Regular ROV inspection of all pipelines will be undertaken.	

13 Conclusions

The key findings of the EIA process for the proposed Victory development can be summarised as follows:

- **Physical Presence:** No significant residual effects on other sea users are predicted as a result of the physical presence of the MODU and vessels during drilling, installation or hook-up and commissioning activities, as well as the long term presence of the Victory subsea infrastructure, associated protection material or 500 m safety exclusion zone.

  It is likely that commercial shipping and recreational vessels will have to adjust their routes to avoid the MODU, vessels and exclusion zone but there is ample sea room for shipping to re-route or avoid the Victory location, as necessary, particularly given the moderate to low density of vessel traffic in the area. A number of measures will be in place to ensure advance notification of the operations is provided. Residual effects on navigation are therefore considered to be **Minor** and not significant. A full collision risk assessment will be undertaken by Corallian to inform the CtL permit applications, required to site the MODU and subsea infrastructure at the Victory location.

  Fishing vessels will be temporarily displaced from the Victory development area for a period of up to five months (May to October) during the drilling and subsea infrastructure installation phases, with an area of 0.8 km^2 surrounding the Victory well lost for the life of the field development. This is considered to be a very small area in comparison to the alternative fishing grounds available in the wider West of Shetland area. The rock berms over the length of the pipeline and umbilical and the PLEM / pigging skid, tie-in and protection structures will all be overtrawable. Residual effects on commercial fisheries are therefore considered to be **Minor** and not significant.

- **Seabed Disturbance:** No significant residual effects on seabed sediments, seabed communities or fish are predicted as a result of disturbance to the seabed during the life of the Victory field development.

  The maximum total area of seabed that will be directly impacted by the Victory development is estimated at around 1.29 km^2. This is a relatively small area in comparison to the seabed available West of Shetland region, with similar water depths, sediment types and benthic communities. In addition, a large proportion of the total seabed disturbance area (ca. 75%) is attributed to MODU anchoring, the discharge of WBM drill cuttings, muds and cement, disturbance from the pipeline and umbilical initiation anchor and wire and temporary lay down areas, where only temporary short to medium term effects are predicted.

  It is, however, recognised that some aspects associated with the Victory development (i.e. installation of the subsea structures, pipeline and umbilical and associated protection material) will have long term impacts on sediment communities, due to permanent habitat change, although direct physical injury of benthic species will only occur when the infrastructure or material is first placed on the seabed. This impact will last the duration of the Victory field development and beyond in the event the field is repurposed for carbon capture and storage.

  An Annex I habitat stony reef assessment (after Irving, 2009) conducted over the Victory development area found one area of 'low' reef at the southern end of the proposed HTT2 pipeline route. Corallian therefore commit to acquire further environmental data along the proposed pipeline route, as required, during the detailed engineering surveys scheduled to be undertaken in 2023, to reconfirm the 2021 survey results and aid micro siting of the pipeline, thereby avoiding any significant impacts to this habitat type.

  Ocean quahog is on the OSPAR list of threatened and/or declining species and, although not recorded during the Victory environmental survey, is known to be present in the wider area. The ocean quahog is highly sensitive to physical pressures and changes in seabed habitat types (i.e. the introduction of new hard substrata). Any impacts will, however, be in a very localised area, such that any effects on the population of ocean quahog in the wider West of Shetland region are not predicted to be significant.

No deep-sea sponge aggregations and no colonies (living or dead) of *L. pertusa* were observed during the Victory environmental survey, which is consistent with the findings of other surveys undertaken in the nearby area.

- **Underwater Noise Emissions:** No significant residual effects are predicted as a result of noise generated from the proposed Victory drilling, vessels operations or piling operations.

  It is possible that short term behavioural effects may be observed among marine mammals and fish as a result of the underwater noise emissions generated during development of the Victory field. However, Corallian will implement a range of measures to mitigate any potential impacts including optimising the duration of drilling and installation activities to minimise vessel usage, timing the piling operations to avoid periods of high sensitivity for marine mammals and fish, and adhering to the JNCC guidelines for minimising injury and disturbance to marine mammals. As a result, any residual effects are predicted to be **Minor** and not significant.

  During the detailed design phase of the project, Corallian will review the possibility of using an alternative foundation design for the subsea structures in order to avoid the need for pile driving, thereby reducing noise emeissions during installation operations.

- **Atmospheric Emissions:** Combustion of hydrocarbons for power generation on the MODU, vessels, and helicopters during the development of the Victory field, as well as flaring of hydrocarbons during the well flow test, will result in atmospheric emissions. During the production phase, gas from the Victory field will be processed at the SGP with processing equipment and support facilities shared with several other producing assets. This minimises the incremental energy demand caused by the development; however, as the SGP is located onshore, the emissions arising at the SGP as result of the Victory development are outside of the scope of this ES.

  At a local level, impacts to air quality arising from the atmospheric emissions generated during the proposed Victory development operations are predicted to be **Negligible**. Emissions will disperse rapidly from source given the open and dynamic metocean environment in the West of Shetland region.

  Due to the residence time of GHG emissions in the atmosphere, it is recognised that development of the Victory field will contribute to climate change impacts in combination with the other projects and activities emitting GHG emissions. Corallian is therefore commited to minimising the amount of GHG emission produced, with the chosen field development concept option producing the lowest levels of GHG emissions relative to the alternative concepts. During drilling and installation operations, vessel days and fuel consumption will be reduced, as far as practicable. The well test and well clean-up activities will be designed not only to achieve their goals but to provide an optimal duration and reduce flaring to minimise the GHG emissions produced. Modern 'green' burners will be utilised to ensure all hydrocarbons are burnt completely.

  The GHG emissions associated with the Victory development represent only a small proportion of GHG emissions typically arising from oil and gas developments in the UKCS and will only contribute a small fraction of CO_2e emissions towards future UK carbon budget targets. Production from Victory also represents significantly lower than average emissions per tonne of oil equivalent produced compared with other gas fields on the UKCS or imported sources. All gas produced from the Victory field will flow to the SGP and will be used domestically and not exported. In summary, development of the Victory gas field provides the UK with a comparatively low carbon indigenous gas source during the transition to renewable energy, helping contribute to energy security and assist in the delivery of Net Zero UK carbon emissions by 2050. The design of the Victory facilities also allows for the Victory field to be re-purposed for carbon capture and storage at a later date, after cessation of production.

  Residual effects on the climate will therefore be **Moderate**, but not significant provided the mitigation measures proposed are implemented.

- **Marine Discharges:** No significant residual effects on water quality, plankton or fish are predicted as a result of routine marine discharges during the development of the Victory field.

  The main operational discharges into the marine environment from the proposed Victory development will occur as a result of the discharge of drill cuttings, muds and cement, residual hydrocarbons when drilling through the payzone, chemicals during drilling, installation and hook-up and commissioning activities and completion brine during well clean-up activities. Upon release, these discharges will be subject to rapid dilution and dispersion and are not expected to persist within the marine environment. Additionally, a number of studies have shown that any impacts will be limited to the local area in the immediate vicinity of the release location.

  Corallian will implement a range of measures to mitigate any potential impacts including undertaking a chemical risk assessment to identify the risk profile of chemicals being used and / or discharged in accordance with the requirements of the Offshore Chemicals Regulations 2002 (as amended). Where practicable, chemicals with a higher risk profile will be substituted out in favour of those with an improved environmental profile. During the proposed drilling operations, any discharges of residual reservoir hydrocarbons will be treated to meet oil-in-water limits of less than or equal to 30 mg/l. The discharge stream will also be monitored and sampled in accordance with an approved Oil Discharge Permit.

  Residual effects from marine discharges are therefore predicted to be **Minor** on water quality and **Negligible** on other receptors impacted and are not significant.

- **Accidental Releases:** All offshore activities associated with the Victory development will carry a potential risk of hydrocarbon pollution to sea; however, hydrocarbon spills from normal oil and gas operations are uncommon and can be effectively mitigated against. In planning its activities, Corallian's primary focus is to ensure that all practicable measures are taken to prevent the occurrence of such accidental events and, should they occur, mitigate their effects. The consequences of an accidental release will vary depending on the quantity and type of hydrocarbon spilt, the wind speed and direction and sea state and the sensitivity of receptors depending on the time of year.

  The worst-case spill scenario from the Victory development would be an uncontrolled flow of light condensate from the proposed 207/1a-F well (i.e. a well blowout). Oil spill modelling has been conducted to determine the fate of Victory hydrocarbons released from this worst case scenario. There is a low potential for a surface slick of condensate to cross the UK/Norwegian median line and a low potential to cross the UK/Faroe Islands median line. There is a moderate possibility shoreline oiling will occur on the Shetland Islands. However, the Victory condensate is a light hydrocarbon and, as such, it would be rapidly broken up by wind and wave action and evaporate. The risk of an accidental release occurring from the Victory development will be minimised through the implementation of physical barriers such as downhole safety valves, maintenance to minimise leaks, and the development and implementation of handling and operational procedures and training.

  Measures to respond to a spill from the MODU or the Victory subsea facilities once operational will be covered in approved oil pollution emergency plans, which will be prepared in advance of drilling operations commencing offshore. As such, the overall risk to the marine environmental from an accidental release of hydrocarbons from the Victory development is considered to range from **Medium** to **Low**, depending on the receptor impacted, but in all cases the risk has been reduced to ALARP through mitigation measures and good industry practice and is therefore not considered to be significant.

In summary, it is concluded that the proposed Victory field development will not result in any significant environmental effects (including transboundary and cumulative effects) provided that all identified mitigation measures are implemented.

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Appendix A: Legislation and Marine Policy

A.1 Applicable Environmental Legislation

Table A.1 identifies some of the key environmental legislation pertinent to the proposed Victory field development operations.

Table A.1. Key Legislation Pertinent to the Proposed Victory Field Development

Legislation	Summary of Requirements	Relevance to Victory Development
The Petroleum Act 1998	Part I of The Petroleum Act empowers the Secretary of State to grant licences to search for and obtain petroleum. The framework Act also regulates: • Offshore activities (Part II) – requires consent to drill wells through the Well Operations Notification System (WONS); • Submarine pipelines (Part III) – through the Pipeline Works Authorisation for construction and installation of a pipeline, and Deposits Consent for pipeline stabilisation deposits; • The abandonment of offshore installations (decommissioning) (Part IV); and, • Hydrocarbon flaring through the provisions of the Flare Consent. The Act also requires a FDP to be submitted to OGA for approval.	All consents and permits relevant to the proposed Victory field development will be in place prior to the commencement of operations.
Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 and associated guidance July 2021	A mandatory ES is required for developments producing >500 tonnes per day of oil, or 500,000 cubic metres per day of gas, and for developments involving pipelines of more than 800 millimetres diameter and 40 kilometres or more in length. Other activities may require an ES depending on the nature of the project and sensitivities.	The project meets the criteria for a mandatory ES as at its peak the Victory development will produce up to 4,209 million cubic metres (148,640 million standard cubic feet) per day of gas and 15.36 tonnes (23.63 cubic metres) of condensate per day. This ES has been produced for submission to Regulators and stakeholders. Public participation will be fulfilled through stakeholder engagement during the statutory public consultation period following the ES submission.

Legislation	Summary of Requirements	Relevance to Victory Development
The Offshore Chemicals Regulations 2002 (as amended)	All offshore activities that use and discharge chemicals during drilling, well intervention, pipeline and / or production operations, require a Chemical Permit. These permits must detail the chemicals to be used and discharged into the marine environment and undertake a risk assessment, where relevant, within the associated permit.	The following Master Application Template (MATs) will be applied for prior to the commencement operations in relation to chemical use and discharge: • Drilling Operations Permit; • Pipeline Operations Permit; Each of these MATs will have a separate Chemical Permit Subsidiary Application Template (SAT). Chemicals used and discharged during the production operations will be permitted via a variation to the TotalEnergies' Edradour existing Production Operations Permit.
The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended)	Prohibits the discharge of oil to sea other than in accordance with the terms and conditions of a permit. Operators of offshore installations must identify all planned oil discharges to relevant waters and apply for the appropriate permits. Oil Discharge Permits will not be required for those chemicals already covered by the Offshore Chemicals Regulations (2002) as amended (i.e. base oils, lubricants etc.). The 2011 amendment redefined the term 'offshore installation' to encompass all pipelines and the term 'release' to cover all unintentional oil emissions. Intentional emissions are referred to as 'discharges'.	Any produced water generated during processing of the Victory fluids will be disposed at the SGP via the existing produced water system and is therefore outside of the scope of this ES
The Merchant Shipping (Oil Pollution Preparedness, Response and Co-operation) Regulations 1998 (as amended)	These Regulations require that every offshore installation and oil-handling facility must have an approved oil pollution emergency plan (OPEP), setting out arrangements for responding to incidents that cause or may cause a hydrocarbon pollution incident at sea. The OPEP must detail methods to prevent such pollution or reducing or minimising its effect. The 2015 Amendment Regulations implement the EU Offshore Safety Directive (2013/30/EU) (EU OSD)	Approved OPEPs will be in place for all lifecycle phases of the Victory field development.

Legislation	Summary of Requirements	Relevance to Victory Development
The Offshore Installations (Emergency Pollution and Control) (EPC) Regulations 2002	These Regulations give the government powers to intervene in the event of an incident or accident involving an offshore installation where: • There is, or may be a risk of, significant pollution; • An operator is failing or has failed to implement effective control and preventative operations. OPRED's role is to monitor, and if necessary intervene, to protect the environment in the event of a threatened or actual pollution incident in connection with an offshore installation.	Approved OPEPs will be in place for all lifecycle phases of the Victory field development and will incorporate the requirements of the EPC Regulations.
The Climate Change Act 2008 (as amended)	The Climate Change Act (2008) establishes a legally binding target for the UK to reduce greenhouse gas emissions by at least 80% by 2050 from 1990 levels. The 2008 Act requires that the UK Government set five-yearly carbon budgets which limit greenhouse gas emissions from all sources, excluding international aviation and shipping. In 2019 this target was revised with the UK planning to reduce all greenhouse gas emissions to net zero by 2050.	All offshore emissions from Victory are associated with the drilling, well completion, installation and commissioning of the Victory Development. As indicated in Section 3.2, these activities are planned during 2024 and, as a consequence, will occur in the 4th UK carbon budget period from 2023 to 2027. For this carbon budget period, the UKs total carbon budget is 1,950 Mt CO_2e. The total estimated Victory CO_2e emissions for this five year period is 22,469 tonnes which is equal to less than 0.0012% of the UK budget, a very small component of the overall emissions in the UK. During the production phase all atmospheric emissions associated with Victory are generated onshore at the SGP and are therefore outside of the scope of this ES; however the development of the Victory field in the wider context of Net Zero is discussed in Section 2.3.2.

Legislation	Summary of Requirements	Relevance to Victory Development
The Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015	These Regulations introduce the specific licensing requirements of the EU OSD. The Regulations stipulate that the licensee cannot appoint an installation or well operator without giving written notice to the licensing authority and place a duty on the licensee to ensure that there are adequate provisions to cover any liabilities that may arise from the offshore operations. They also make provision for the licensing authority, in exceptional circumstances (such as the dismissal of an operator), to appoint operators in respect of those licences.	Corallian is planning to appoint a well operator and a pipeline operator, subject to approval by the OGA under The Offshore Petroleum Licensing (Offshore Safety Directive) Regulations 2015. The appointed well operator will manage the development drilling and well completion operations, as well as any future well intervention (maintenance) and subsequent well abandonment operations. The appointed pipeline operator will manage any pipeline interventions once the field goes into production and subsequent pipeline abandonment activities.
OSPAR Recommendation 2003/5 to Promote the Use and Implementation of Environmental Management Systems by the Offshore Industry	All operators of offshore installations on the UKCS are required to have in place an independently verified Environmental Management System (EMS) designed to achieve: the environmental goals of the prevention and elimination of pollution from offshore sources and of the protection and conservation of the maritime area against other adverse effects of offshore activities and to demonstrate continual improvement in environmental performance. OSPAR recognises the ISO 14001 & Eco-Management and Audit Scheme International standards as containing the necessary elements to fulfil these requirements. All operators are also required to provide a public statement of their environmental performance on an annual basis.	Corallian has a HSE MS in place and will preferentially select contractors with suitable management systems in place prior to operations.
OSPAR Decision 98/3 on the disposal of Disused Offshore Installations	This decision prohibits the dumping and leaving wholly or partially in place of disused offshore installations with some exceptions for large structures (derogation cases).	On cessation of production at the field, the Victory field will be decommissioned in its final state in accordance with the requirements of prevailing UK and international law and following a Comparative Assessment of the decommissioning options and an EIA.
The Energy Act 2008	Part 4A of the Energy Act 2008 administers control for Section 34 of the Coastal Protection Act which requires a permit for the placement of surface and some subsurface structures deemed to pose a navigation risk. It allows OPRED to insist upon the provision of navigational markings that are considered appropriate for the proposed offshore structure or operations.	Consent to Locate permits will be in place for the MODU during drilling operations and subsea infrastructure at the Victory location.

Legislation	Summary of Requirements	Relevance to Victory Development
The International Convention for the Prevention of Pollution from Ships (MARPOL 73/78)	The Convention was designated to minimise pollution of the seas including dumping of wastes, oil and exhaust pollution. The Convention is made up of six annexes: • Annex I – covers pollution from oil and oily water (transposed into UK legislation through The Merchant Shipping Act 1995 and The Merchant Shipping (Prevention of Oil Pollution) Regulations 1996 (as amended)); • Annex II – covers pollution by noxious liquid substances in bulk (transposed into UK legislation through The Merchant Shipping (Dangerous or Noxious Liquid Substances in Bulk) Regulations 2004); • Annex III – covers pollution by harmful substances carried by sea in packaged form (transposed into UK legislation through The Merchant Shipping Act 1995); • Annex IV – covers pollution through sewage from ships (transposed into UK legislation through The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008 (as amended)); • Annex V – covers pollution by garbage from ships (transposed into UK legislation through The Merchant Shipping (Prevention of Pollution by Sewage and Garbage from Ships) Regulations 2008 (as amended)); • Annex VI – covers prevention of air pollution from ships (transposed into UK legislation by The Merchant Shipping (Prevention of Air Pollution from Ships) Regulations 2008 (as amended)).	The MODU and all other contracted vessels will meet MARPOL requirements throughout all stages of the project. This includes, but is not limited to, adhering to regulations and limits on oily discharges (drainage water, crude oil washing etc.), sewage, garbage, and emissions to air.
The Marine (Scotland) Act 2010	This Act covers inshore and offshore waters and provides a framework to help balance the competing demands on Scotland's seas. It introduces a duty to protect and enhance the marine environment and includes measures to help boost economic investment and growth in areas such as marine renewables. It also sets out a marine planning and licensing regime for offshore activities and measures for improved marine conservation through the designation of Scottish Marine Protected Areas.	The planning system and synergistic use of the marine environment has been taken into account throughout the ES (refer to Tables A.2 and A.3).
The Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007 (as amended)	These Regulations implement the EU Habitats (92/43/EEC) and Birds Directives (79/409/EEC) and ensure that certain activities that may have an effect on important species and habitats can be managed. The 2010 amendment makes it an offence to deliberately disturb European Protected Species (species listed under Annex IV of the Habitats Directive) in such a way as to be likely to impair their ability to survive, breed, or rear or nurture their young; or, in the case of animals of a	The potential impacts on species and habitat of importance have been discussed where relevant in Sections 7, 8 and 11. The potential impacts on European Protected Species have been assessed in Section 8. This has concluded that the Victory field

Legislation	Summary of Requirements	Relevance to Victory Development
	hibernating or migratory species, hinder their ability to hibernate, migrate or significantly affect the local distribution or abundance of that species.	development is not expected to constitute an offence under this legislation.
The Offshore Petroleum Activities (Conservation of Habitats) Regulations 2001 (as amended)	These Regulations require consent for geological surveys related to oil and gas activities. The Regulations also require that the Secretary of State consider whether to undertake a Habitats Regulation Assessment (Appropriate Assessment) (HRA / AA) if the proposed activities are likely to have a significant impact on a relevant Natura 2000 site or feature (Annex I habitats, Annex II or European Protected Species).	Separate consents for future geophysical or geotechnical site surveys will be applied for or relevant notifications submitted, as necessary. These may be required prior to installation activities and may be required for monitoring subsea infrastructure during production. As the proposed development is not expected to have a significant effect on a Marine Protected Area, a HRA / AA is not expected to be required.

A.2 Scottish National Marine Plan

Scotland's National Marine Plan was developed following the implementation of the Marine (Scotland) Act 2010 which fulfils the requirements of EU Directive 2014/89/EU by setting out a framework for marine spatial planning to promote the sustainable use of the marine environment (The Scottish Government, 2015). The key policies contained within the Plan that are relevant to the proposed Victory field development and how these have been incorporated into the proposed operations are provided in Table A.2 below.

Table A.2. General Policies Contained within Scotland's National Marine Plan that are of Relevance to the Proposed Victory Field Development

Policy	Addressed by the Victory Development Project
GEN 1 General planning principle: There is a presumption in favour of sustainable development and use of the marine environment when consistent with the policies and objectives of the Plan.	The Victory field development will consider the requirements of Scotland's Marine Plan and will be consistent with the sustainable use of the marine environment and will consider the environmental and socio-economic sensitivities in the potential zone of influence of the project throughout operations.
GEN 2 Economic benefit: Sustainable development and use which provides economic benefit is encouraged when consistent with the objectives and outcomes of the Plan.	The Victory field development will provide economic and social benefit to the UK and Scotland's oil and gas sector in particular, aiding energy security in the future.
GEN 3 Social benefit: Sustainable development and use which provides social benefits is encouraged when consistent with the objectives of the Plan	
GEN 4 Co-existence: Proposals which enable co-existence with other development sectors and activities within the Scottish marine area are encouraged in planning and decision-making processes, when consistent with policies and objectives of the Plan.	Corallian has undertaken a scoping exercise with statutory consultees and other stakeholders to ensure that the expectations of concerned parties have been incorporated into the project at an early stage. The outcomes of scoping and consultation are detailed in Section 1 of this ES. Continued liaison with other users of the area will be undertaken throughout operations to achieve a synergistic approach to the development of the area.

Policy	Addressed by the Victory Development Project
GEN 5 Climate change: Marine planners and decision makers must act in the way best calculated to mitigate, and adapt to, climate change.	Corallian and its contractors are committed to minimising atmospheric emissions where possible. Discussion on net zero and potential climate change impacts are assessed in Sections 2 and 9.
GEN 9 Natural heritage: Development and use of the marine environments must: a) Comply with legal requirements for protected areas and protected species; b) Not result in significant impact on the national status of PMFs; c) Protect and, where appropriate, enhance the health of the marine area.	The environmental baseline and potential presence of protected species or habitats, including PMFs has been fully characterised through the EIA scoping exercise, environmental site survey work and desktop study. The ES has undertaken an assessment of the potential impacts of certain aspects on potentially sensitive receptors and has identified, where appropriate, mitigation measures to manage potential impacts.
GEN 10 Invasive non-native species: Opportunities to reduce the introduction of invasive non-native species to a minimum or proactively improve the practice of existing activity should be taken when decisions are being made.	Where possible, vessels originating from European waters will be preferentially selected, to minimise the possibility of introduction of potentially invasive species. Ballast water exchange will be undertaken offshore. Relevant vessels will have ballast water management systems and procedures in place.
GEN 11 Marine litter: Developers, users and those accessing the marine environment must take measures to address marine litter where appropriate. Reduction of litter must be taken into account by decision makers.	Corallian and its contractors will adhere to the Waste Hierarchy Principles and will minimise the generation of waste as a priority. Vessels will have Garbage Management Plans in place in accordance with MARPOL 73/78 which will detail waste handling, storage and disposal procedures to minimise the generation of marine litter.

Policy	Addressed by the Victory Development Project
GEN 12 Water quality and resource: Developments and activities should not result in a deterioration of the quality of waters to which the Water Framework Directive (WFD), MSFD or other related Directives apply.	The MSFD aims to minimise concentrations of contaminants in biota, sediments and water. Legislation such as The Offshore Chemicals Regulations (2002), and enacting legislation, and The Offshore Petroleum Activities (Oil Pollution Prevention and Control) Regulations 2005 (as amended) are the key legislation that govern the discharges of certain contaminants from oil and gas activities. It is recognised that standards of contaminants are generally only exceeded for legacy chemicals that are toxic, persistent and that will bioaccumulate and in areas close to the sources of historic pollution (DEFRA, 2015). Corallian and its contractors will minimise the discharge of contaminants into the marine environment. In addition, chemical risk assessment will be undertaken to identify chemicals that will not have significant effects on the marine environment. Note that the WFD applies to inshore waters only and is therefore not applicable to the Victory field development.
GEN 13 Noise: Development and use in the marine environment should avoid significant adverse effects of man-made noise and vibration, especially on species sensitive to such effects.	The potentially significant environmental impacts on sensitive marine fauna (specifically marine mammals and fish) that may arise from noise generated throughout the life of the proposed Victory field development is assessed in Section 8 of this ES. To minimise potential impacts on marine fauna, the generation of underwater noise will be minimised where possible and any piling activities in particular will adhere to the JNCC protocol for minimising the risk of injury to

Policy	Addressed by the Victory Development Project
	marine mammals (JNCC, 2010b). Details of piling operations will be submitted to the Marine Noise Registry in accordance with the MSFD.
GEN 14 Air quality: Development and use of the marine environment should not result in the deterioration of air quality and should not breach any statutory air quality limits.	Corallian and its contractors are committed to minimising atmospheric emissions where possible. The sources of atmospheric emissions throughout the project have been identified and quantified in Section 3 based on worst-case assumptions emissions. The potential impacts of atmospheric emissions have been discussed in Section 9 and are expected to disperse rapidly and become diluted with increasing distance from the source.
GEN 17 Fairness: All marine interests will be treated with fairness and in a transparent manner when decisions are being made in the marine environment.	These policies have been addressed in the EIA process through scoping exercise, the outcome of which is discussed in Section 1 of this ES. In addition, Offshore Oil and Gas Exploration, Production, Unloading and Storage (Environmental Impact Assessment) Regulations 2020 also allows for public participation following the submission of the ES.
GEN 18 Engagement: Early and effective engagement should be undertaken with the general public and all interested stakeholders to facilitate planning and consenting processes.	
GEN 19 Sound evidence: Decision making in the marine environment will be based on sound scientific and socio-economic evidence.	This ES has been based on robust data sources to inform the EIA process, including the survey undertaken at the Victory development location in 2021.
GEN 21 Cumulative impacts: Cumulative impacts affecting the ecosystem of the marine plan area should be addressed in decision-making and plan implementation.	Cumulative impacts related to the potentially significant aspects have been identified in the impacts Sections of this ES (Sections 6 – 11).

Table A.3 outlines the marine planning policies for the oil and gas sector (The Scottish Government, 2015). These policies outline how oil and gas activities are expected to develop in the longer term and issues to be addressed to ensure they grown sustainably. Policies for each sector should be read in conjunction with the general policies provided in Table A.2. Key objectives for the offshore oil and gas sector are:

- Maximise the recovery of reserves through a focus on industry-led innovation, enhancing the skills base and supply chain growth;
- An industry which delivers high-level risk management across all its operations and that it is especially vigilant in more testing current and future environments;
- Continued Technical development of enhanced oil recovery and exploration, and the associated seismic activity carried out according to the principles of the BAT and Best Environmental Practice (BEP) approach;
- Where possible, to work with emerging sectors to transfer the experience, skills and knowledge built up in the oil and gas industry to allow other sectors to benefit and reduce their environmental impact.

In addition to the sector-specific policies described in Table A.3, a number of key issues for marine planning have been identified for the oil and gas sector including 'interactions with other users'. Key interactions with oil and gas activities include renewables, carbon capture and storage (CCS) and fishing. Of these interactions, only fishing is of relevance to the proposed Victory field development due to a lack of suitable conditions and infrastructure for renewables or CCS. The Marine Plan highlights the requirement for an 'exclusion buffer zone' around infrastructure and the resultant exclusion of fishing activity or avoidance of areas due to the presence of seabed obstructions. These potential interactions have been assessed in Section 6 of this ES.

Table A.3. Sector Policies Related to Oil and Gas Developments According to Scotland's National Marine Plan

Marine Planning Policies	Supported Strategic Objectives	Addressed by the Victory Development Project
OIL & GAS 1: The Scottish Government will work with OPRED, the OGA and the industry to maximise and prolong oil and gas exploration and production whilst ensuring that the level of environmental risks associated with these activities are regulated. Activity should be carried out using the principles of BAT and BEP. Consideration will be given to key environmental risks including the impacts of noise, oil and chemical contamination and habitat change.	Economic Social Climate Change – Adaptation Marine Ecosystem	The development concept for Victory comprises a subsea development, tied back to the TotalEnergies operated, Greater Laggan Area (GLA) infrastructure, thereby minimising the impact on the environment and other users of the sea. Key environmental risks have been identified in the assessment sections of this ES (Sections 6 – 11).
OIL & GAS 2: 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 processes.	Economic Social	Following cessation of production at Victory, a comparative assessment and EIA of the decommissioning options for the field will be undertaken to determine the best fate for all infrastructure from a technical, economic, safety and environmental perspective. The potential for the infrastructure to be re-used in the future has also been considered during the design phase of the project. The casing programme for the proposed Victory development well has been designed so it is potentially suitable for future re-use as a CO_2

Marine Planning Policies	Supported Strategic Objectives	Addressed by the Victory Development Project
		injection well and the design of the Victory production pipeline will also be suitable to transport dry CO_2 (see Section 2.3.4).
OIL & GAS 3: Supporting marine and coastal infrastructure for oil and gas developments, including for storage, should utilise the minimum space needed for activity and should take into account environmental and socio-economic constraints.	Economic Marine Ecosystem	The development concept for Victory comprises a subsea development, tied back to TotalEnergies operated, Greater Laggan Area (GLA) infrastructure, thereby minimising the impact on the environment and other users of the sea.
OIL & GAS 6: Consenting and licensing authorities should be satisfied that adequate risk reduction measures are in place, and that operators should have sufficient emergency response and contingency strategies in place that are compatible with the National Contingency Plan and the Offshore Safety Directive.	Social Marine Ecosystem	Accidental events that may arise during the Victory field development have been assessed in Section 11 this ES, along with measures in order prevent their occurrence or to minimise any potentially significant adverse effects.

A.3 The Shetland Islands Regional Marine Plan

The Shetland Islands Regional Marine Plan (SIRMP) was formally initiated in 2016, the plan is currently in draft format and has been submitted to the Scottish Ministers for adoption and publication. The SIRMP reflects the requirements for regional marine planning under the Marine (Scotland) Act 2010 and associated Delegation of Functions (Regional Marine Plan for the Scottish Marine Region for the Shetland Isles) Direction 2016. The policy framework is in line with Scotland's NMP. The key policies contained within the SIRMP that are relevant to the proposed Victory field development and how these have been incorporated into the proposed operations are provided in Table A.4 below.

Table A.4: General Policies Contained within the Shetland Islands Regional Marine Plan (SIRMP) that are of Relevance to the Proposed Victory Field Development

Policy	Addressed by the Victory Development Project
DEV1 Marine Developments: Proposals for marine-related developments must comply with all policies included in Policy Framework Section (a) and (b), Policies MP DEV2 and Policy MP FISH1.	The proposed Victory field development will consider the requirements of Shetland Islands Regional Marine Plan and will be consistent with the sustainable use of the marine environment and will consider the environmental and socio-economic sensitivities in the potential zone of influence of the project throughout operations.
DEV2 Decommissioning of Assets: Applications for marine-related developments should, where directed by the consenting authority or regulator, be supported by a decommissioning plan to ensure the removal of redundant infrastructure.	Following cessation of production at Victory, a comparative assessment and EIA of the decommissioning options for the field will be undertaken to determine the best fate for all infrastructure from a technical, economic, safety and environmental perspective.
WAT1 Water Ecology: Development shall not cause any water body to deteriorate in ecological status nor prevent the achievement of established objectives set out in the Scotland River Basin Management Plan.	Corallian and its contractors will minimise the discharge of contaminants into the marine environment In addition, chemical risk assessment will be undertaken to identify chemicals that will not have significant effects on the marine environment. The MODU and all other contracted vessels will meet MARPOL requirements throughout all stages of the project. This includes, but is not limited to, adhering to regulations and limits on oily discharges (drainage water, crude oil washing etc.), sewage, garbage, and emissions to air.
WST1 Waste Minimisation: All applications shall include a waste minimisation and management plan to ensure the safe disposal of waste material and debris associated with the construction, operation and decommissioning stages of the development.	Corallian and its contractors will minimise the production of waste as practically as possible and ensure waste management plans are in place. The MODU and all other contracted vessels will meet MARPOL requirements throughout all stages of the project. This includes, but is not limited to, adhering to regulations and limits on garbage.
NOISE1 Minimising Levels of Surface and Underwater Noise and Vibration: Applications for marine-related development and use should, where directed by the consenting authority or regulator: a) submit a surface and underwater noise and vibration impact assessment or supporting information to describe the duration,	Underwater noise and the potential impacts on the marine environment is discussed in Section 8.

Policy	Addressed by the Victory Development Project
type and level of noise and vibration expected to be generated at all stages of the development (construction, operation, decommissioning); and b) include mitigation measures to minimise the adverse impacts associated with the duration and level of noise and vibration activity	
CLIM1 Climate Change Mitigation: Applications for marine-related developments should demonstrate, in a format approved by the consenting authority or regulator, that: a) resource use; b) energy use; and c) emissions have been assessed and minimised as part of the overall development proposal.	Corallian and its contractors are committed to minimising atmospheric emissions where possible. Net zero and potential climate change impacts are assessed in Sections 2 and 8.
CLIM2 Climate Change Adaptation: Applications for marine-related developments should demonstrate that the impacts of climate change over the lifetime of the development have been considered and minimised as part of the overall development proposal.	
MPA1 Plans or projects that may affect SACs, SPAs (collectively known as European sites) and Ramsar Sites: Developments or uses that might affect a European site must comply with legal requirements for these protected areas and must be subject to a Habitats Regulations Appraisal (HRA) undertaken by a competent authority (normally the licensing or consenting authority/body).	As the proposed development is not expected to have a significant effect on a Marine Protected Area, a HRA / AA is not expected to be required.
MPA2 Nature Conservation Marine Protected Areas (NCMPAs): Development capable of affecting any Nature Conservation MPA will only be permitted where it has been adequately demonstrated, to the satisfaction of the consenting authority and Marine Scotland and with advice from NatureScotSNH, that the proposal has had due regard to the conservation objectives of the designated site and either:	The proposed development is not expected to have a significant effect on a Nature Conservation Marine Protected Area

Policy	Addressed by the Victory Development Project
a) there will be no significant risk of hindering the conservation objectives of the Nature Conservation MPA, or b) there is an urgent need for the development to be approved, or c) the benefit to the public outweighs the risk of damage to the environment and there are no alternative solutions.	
SPCON2 Protection of Wild Birds and Their Habitats Outside Designated Sites: If a wild bird protected under the Wildlife and Countryside Act 1981 (as amended), the Nature Conservation (Scotland) Act 2004 or listed in Annex 1 of the EC Birds Directive is present on site, or may be affected by a proposed development a plan should be provided to avoid or mitigate any adverse effects on the species.	No significant impacts on wild birds are expected from the Victory development.
SPCON4 Priority Marine Features: Developments or uses must demonstrate they will have no significant adverse direct or indirect effect on a Priority Marine Feature (PMF)	The environmental baseline and potential presence of protected species or habitats, including PMFs has been fully characterised through the EIA scoping exercise, environmental site survey work and desktop study. The ES has undertaken an assessment of the potential impacts of certain aspects on potentially sensitive receptors and has identified, where appropriate, mitigation measures to manage potential impacts.
BIOD1 Furthering the Conservation of Biodiversity: Development and use of the marine environment will be considered against public bodies' obligation to further the conservation of biodiversity and the ecosystem services it delivers. Development and use of the marine environment must protect, and where appropriate enhance the health of the Shetland marine area.	The environmental baseline and potential presence of protected species or habitats, including PMFs has been fully characterised through the EIA scoping exercise, environmental site survey work and desktop study. The ES has undertaken an assessment of the potential impacts of certain aspects on potentially sensitive receptors and has identified, where appropriate, mitigation measures to manage potential impacts.
FISH1 Safeguarding Fishing Opportunities: Developments will only be permitted where it can be demonstrated that: a) there will be no significant negative impact or permanent significant obstruction to an important fishing area28; b) there will be no significant environmental impact to a known/designated spawning, nursery area or habitats or	There will be minimal impacts on fishing activity from the Victory development, as described in Section 6.

Policy	Addressed by the Victory Development Project
species which are important for commercially important species of fish; c) it will not cause a navigational hazard for commercial fishermen; d) there will be no significant negative effect to the cultural importance of fishing, particularly for vulnerable coastal communities; and e) there is no reasonable alternative and any such adverse effects are clearly outweighed by social, environmental or economic benefits of national importance	
OAG1 Oil and Gas Proposals: Exploration and extraction for oil and gas within 12 nautical miles of the coast will only be permitted where: a) the proposal complies with all policies included in Policy Framework Section (a) and (b) and Policy MP DEV1; b) there will be no adverse effects on the integrity of a European site or a proposed site; c) an acceptable Emergency Response Plan is provided in agreement with the appropriate consenting authority for any accidental release of oil or gas and related hazardous substances is provided; d) the proposal includes all elements such as connections to shore base and infrastructure; and e) an appropriate monitoring programme and detailed restoration and maintenance proposals are included.	N/A

Appendix B: Oil Spill Modelling Study

This appendix presents the results of the oil spill modelling study undertaken to support the Victory field development ES in order to gain an understanding of the behaviour of a potential worst-case oil spill scenario in the marine environment originating from Victory. The modelling has been completed in line with the OPRED Guidance Notes for Preparing Oil Pollution Emergency Plans for Offshore Oil & Gas Installations and Relevant Oil Handling Facilities (Revision 6: September 2021).

B.1 OILMAP Spill Modelling Package

This oil spill modelling study has been undertaken using OILMAP (Version 7.2), an advanced oil modelling tool developed and licensed by RPS ASA. OILMAP provides rapid predictions of the fate and transport of spilled oil and can calculate the probability of key areas being impacted. The following OILMAP system models were used for this study.

B.1.1 Single Trajectory and Fates Model

The trajectory and fates model predicts the transport and weathering of oil from instantaneous or continuous spills. Predictions show the location and concentration of the surface and subsurface oil versus time. The model estimates the temporal variation of the oil's areal coverage, oil thickness, and oil viscosity.

The model also predicts the oil mass balance or the amount of oil on the free surface, in the water column, evaporated, on the shore, and outside the study domain versus time. The fate processes in the model include spreading, evaporation, entrainment or natural dispersion, emulsification and an oil-shoreline interaction:

- **Spreading** is represented using the thick slick portion of Mackay *et al*. (1980, 1982) thick-thin approach.
- **Evaporation** is based on Mackay's analytic formulation parameterized in terms of evaporative exposure (Mackay *et al*., 1980, 1982).
- **Entrainment or Natural Dispersion** is modelled using Delvigne and Sweeney's (1988) formulation which explicitly represents oil injection rates into the water column by droplet size. The entrainment coefficient, as a function of oil viscosity, is based on Delvigne and Hulsen (1994).
- **Emulsification** of the oil, as function of evaporative losses and changes in water content, is based on Mackay et al. (1980, 1982).
- **Oil-Shoreline Interaction** is modelled based on a simplified version of Reed *et al*. (1989) which formulates the problem in terms of a shore type dependent holding capacity and exponential removal rate.

B.1.2 Stochastic Model

The stochastic model is useful as a contingency planning tool. It is used to determine the range of distances and directions oil spills from a particular site are likely to travel, given the historical wind speed and direction data for the area. The stochastic model performs a large number of single simulations (typically 100 individual trajectory runs) for a given spill site, varying the wind and tidal conditions for each scenario. These trajectories are used to predict probabilities and minimum time that water surface and shoreline areas will be oiled by a release from the given site.

Figure B.1 shows how a simple probability map is created. The example uses four trajectory runs to create a final probability map. Following the same example, Figure B.2 demonstrates how to interpret probability and features of interest (e.g. marine protected areas).

Figure B.1: Diagram to show how stochastic probability maps are made

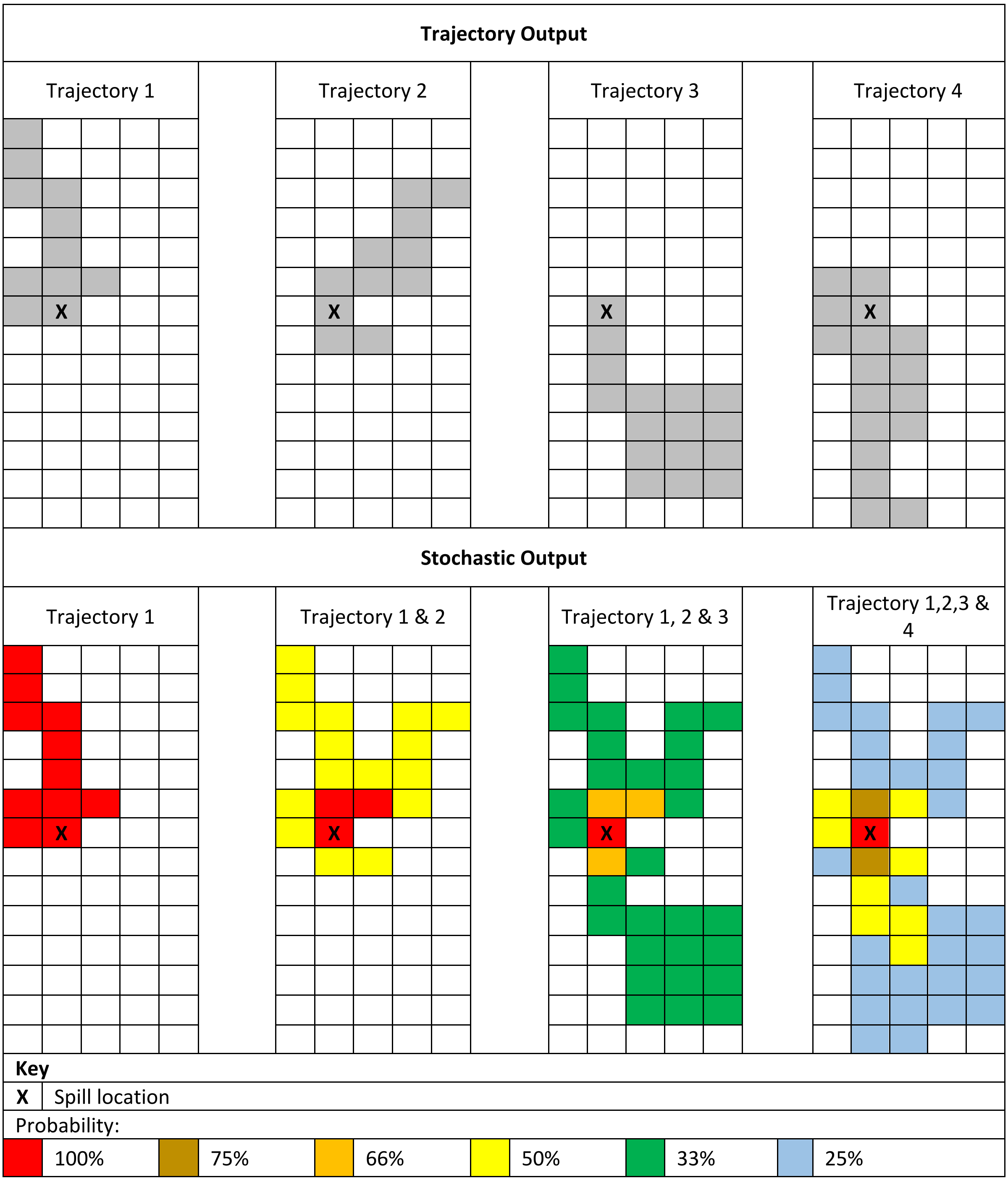
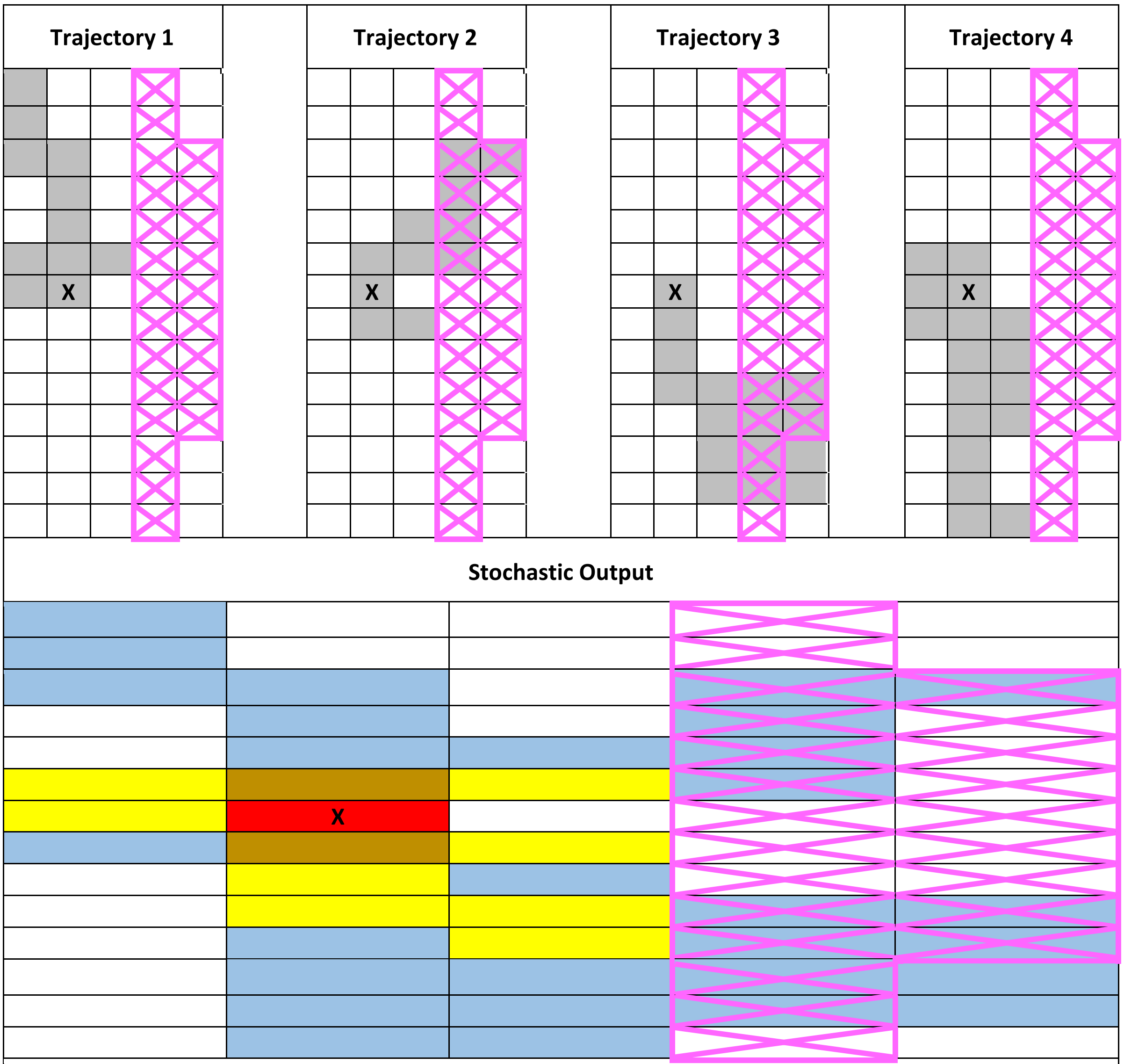


Figure B.2: Interpretation of Probability Mapping (Probability Grid vs Context Driven)



Key

X	Spill location
	Marine Protected Area

Gridded Probability Output:

	100%		75%		66%		50%		33%		25%

Interpretation of Probability

A grid is over laid onto the trajectory runs to produce the gridded probability output. The grid 'cell size' is important in determining the resolution of the results. A typical grid cell size for a blowout scenario is 1 km x 1 km.

Overlaying features (e.g. Marine Protected Areas) onto a probability map can be misleading when interpreting results. In the example above, the gridded probability suggests that there is a 25 % probability of the Marine Protected Area being hit by oil. Whereas, a context driven approach that counts the number of trajectory runs that enter the Marine Protected Area produces a probability of 50 % (i.e. two trajectory simulations out of four enter the Marine Protected Area).

Therefore, to avoid underestimating probability a context driven approach is used when reporting results.

B.2 Modelled Scenario

B.2.1 Worst Case Spill Scenario

The following worst case spill scenario has been modelled for the Victory development:

- Subsurface blowout release from the Victory development well with a cumulative release of 33,000 barrels (bbl) (5,247 m^3) of 85° API condensate, released over a period of 60 days.

B.2.2 Model Input Parameters

The model input parameters for the Victory blowout scenario are detailed in Table B.1.

Table B.1: Model Input Parameters for a Subsurface Blowout in the Victory Field

<table>
<tr><th colspan="9">Scenario 1: Well Loss Parameters</th></tr>
<tr><td colspan="2">Loss from Well / FPSO / Rig (please specify)</td><td colspan="2">Well Blowout</td><td colspan="3">Instantaneous Loss?</td><td colspan="2">No</td></tr>
<tr><td colspan="2">Worst-case volume</td><td colspan="2">33,000 bbl (5,247 m³)</td><td colspan="3" rowspan="2">Will the well self-kill? If yes, when</td><td colspan="2" rowspan="2">No, it is assumed a relief well would be required.</td></tr>
<tr><td colspan="2">Flow rate</td><td colspan="2">550 bbl per day (87 m³ per day)</td></tr>
<tr><td colspan="2">Justification for predicted worst-case volume</td><td colspan="7">This represents the anticipated worst case blowout scenario for the Victory development in terms of both the volume of condensate which would be released and the duration of the spill (i.e. it assumes the flow can only be stemmed by drilling a relief well which would take a total of 60 days to drill).</td></tr>
<tr><th colspan="9">Location</th></tr>
<tr><td colspan="2">Spill Source point Latitude (N/S)</td><td colspan="2">60° 58’ 8.2’’ N</td><td colspan="3">Spill source point Longitude (E/W)</td><td colspan="2">01° 54’ 38.5’’ E</td></tr>
<tr><td colspan="2">Installation / Facility Name</td><td colspan="2">Proposed Victory Development Well</td><td colspan="3">Quad / Block</td><td colspan="2">207/1a</td></tr>
<tr><th colspan="9">Hydrocarbon Properties</th></tr>
<tr><td colspan="2">Hydrocarbon name</td><td colspan="7">Condensate</td></tr>
<tr><td colspan="2">Assay available</td><td colspan="2">No</td><td colspan="3">Was an analogue used for spill modelling?</td><td colspan="2">Yes – the Condensate Sleipner assay was amended to match the Victory Condensate API.</td></tr>
<tr><td rowspan="2">Analogue</td><th>Name</th><th>ITOPF Category</th><th>Specific Gravity</th><th>API</th><th>Viscosity at temp</th><th>Pour Point (°C)</th><th>Wax Content (%)</th><th>Asphaltene Content (%)</th></tr>
<tr><td>Condensate Sleipner</td><td>Group 1</td><td>0.65</td><td>85</td><td>0.745cP @ 20°C; 0.730cP @ 50°C</td><td>-30</td><td>0</td><td>1</td></tr>
<tr><th colspan="9">Metocean Parameters</th></tr>
<tr><td rowspan="2">Sea surface temperature</td><td colspan="2">Winter (Dec – Feb)</td><td colspan="2">8°C</td><td colspan="2">Summer (June – Aug)</td><td colspan="2">12°C</td></tr>
<tr><td colspan="2">Spring (Mar – May)</td><td colspan="2">9°C</td><td colspan="2">Autumn (Sep – Nov)</td><td colspan="2">10°C</td></tr>
<tr><td rowspan="2">Wind data</td><td colspan="2">Data period</td><td colspan="6">2008 – 2018</td></tr>
<tr><td colspan="2">Data reference</td><td colspan="6">NAVGEM (Navy Global Environmental Model)</td></tr>
<tr><td rowspan="2">Current data</td><td colspan="2">Data period</td><td colspan="6">2008 – 2018</td></tr>
<tr><td colspan="2">Data reference</td><td colspan="6">HYCOM (HYbrid Coordinate Ocean Model) general ocean circulation model and HYDROMAP hydrodynamic model</td></tr>
</table>

Modelled Release Parameters			
Surface or Subsurface	Subsurface	**Depth**	150 m
Release duration	60 Days	**Instantaneous?**	No
Persistence duration	10 Days	**Release rate**	550 bbl / day (87 m^3 / day)
Total simulation time	70 Days	**Total release**	33,000 bbl (5,247 m^3)
Release Turbulence	Turbulent dispersion uses the Delvigne and Sweeny (1988) droplet size distribution. The following release turbulence has been selected: • High Release Turbulence (maximum droplet size = 200 µm). Suitable for well blowout under pressure typically with significant gas quantities. Oil will rise slowly to reach the sea surface.		
No. of Runs	100 simulation runs per season		
Stochastic Parameters			
Probability grid (Grid Cell Size)	Fixed Cell Size: Cell Size (X and Y axis) = 1,000 m Cell Size (Z axis) = 150 m		
Distribution of Mass On Grid Cells	Fixed Mass (mass of spillet is placed only in the grid cell that intersects with the centre of the spillet, without any spreading). Mass is not distributed to any other grid cells.		
Minimum Thresholds	Surface Thickness:	0.0003 mm	
	Shoreline Thickness:	0.001 mm	
	Water Column Concentration:	1.0 ppb	
Oil Spill Modelling Software			
Name of software	OILMAP	**Version**	7.2.728.1227

B.2.3 Reporting Thresholds

Probability and Minimum Time

Table B.2 outlines the minimum oiling thresholds used for this study to determine the probability and minimum time for oiling.

Table B.2: Minimum Oiling Thresholds used for Probability and Minimum Time Reporting

Category	Threshold	Justification
Surface	Minimum Thickness of 0.3 µm	The OPRED Guidance Notes for Preparing OPEPs for Offshore Oil & Gas Installations and Relevant Oil Handling Facilities (Revision 6: September 2021) states that model results must be displayed to an oil thickness of 0.3 µm.
Water Column	Minimum Concentration of 1.0 ppb (total oil)	Screening threshold for potential effects on sensitive organisms & socio-economic activity (e.g. seafood production) (Trudel, 1989; French-McCay, 2002; French-McCay, 2004; French-McCay, *et al*. 2012).

Category	Threshold	Justification
Shoreline	Minimum Thickness of 1.0 µm	This threshold has been selected for potential effects on socio-economic resource uses, as this amount of oil may conservatively trigger the need for shoreline clean-up on amenity beaches. And impact shoreline recreation and tourism (French-McCay, *et al*. 2011 and French-McCay, *et al*. 2012). Shoreline oiling at this threshold may appear as a coat, patches or scattered tar.

Surface Oiling Severity

The surface oil thickness key in Table B.3 is derived from the Bonn Oil Appearance Code (BOAC). Mapping surface oil thickness by the BOAC will help determine surface oiling severity in the spatial context.

Table B.3: The Bonn Agreement Oil Appearance Code

Code	Description - Appearance	Layer Thickness Interval (µm)	Litres per km^2	Colour
1	Sheen (silvery/grey)	0.04 to 0.30	40 – 300	
2	Rainbow	0.30 to 5.0	300 – 5000	
3	Metallic	5.0 to 50	5000 – 50,000	
4	Discontinuous True Oil Colour	50 to 200	50,000 – 200,000	
5	Continuous True Oil Colour	More than 200	More than 200,000	

Water Column Oiling Severity

Table B.4 details four different thresholds for water column oiling concentrations and the effect on marine fauna. The different thresholds are derived from various research papers and will help determine sub surface oiling severity in the spatial context.

Table B.4: Water Column Oil Concentration Thresholds

Threshold for Water Column Oil Concentration (ppb)	Justification	Colour
1	Screening threshold for potential effects on sensitive organisms & socio-economic activity (e.g. seafood production) (Trudel, 1989; French-McCay, 2002; French-McCay, 2004; French-McCay, et al. 2012).	
58	Nilsen *et al*. (2006) developed species sensitivity dose-response curves to assess the impact to organisms from different water column hydrocarbon concentrations. A 5th percentile LC_{50}[1] for Total Hydrocarbon Concentrations (THC) was reported at 58 ppb. The 58 ppb concentration is a conservative lethal exposure value for marine fauna as it is below the LC_{50} for 95 % of species. At this concentration mortality is highly unlikely. However, toxicological effects may be both short and long term.	

Threshold for Water Column Oil Concentration (ppb)	Justification	Colour
70.5	Smit *et al*. (2009) calculated an EC_5 for growth, reproduction and survival of marine organisms of 70.5 ppb THC based on laboratory experiments performed at IRIS (Norway). The dataset included organisms representing five different phyla (fish, crustaceans, polychaets, echinoderms and molluscs). The 70.5 ppb figure is the OSPAR recommended predicted no-effect concentration (OSPAR, 2014).	
100	Vikebø *et al*. (2013) used 1 ppb total Polycyclic Aromatic Hydrocarbons (PAHs) as the lethal effect level (and 0.1 ppb PAHs as the sub lethal effect level) to simulate the impact on cod larvae from a major oil spill originating from various locations outside the Norwegian coast, and coinciding with the spawning season of Barents Sea cod (*Gadus morhua*). Soluble PAHs are approximately 1 % of the THC mass (1 ppb PAH = 100 ppb THC).	

Shoreline Oiling Severity

Table B.5 details three different thresholds for shoreline oiling concentrations that represent light oiling, moderate oiling and heavy oiling. The shoreline oiling classifications are derived from the ITOPF Technical Information Paper No.6 'Recognition of oil on shorelines (ITOPF, 2014). The shoreline oiling classifications will help determine shoreline oiling severity in the spatial context.

Table B.5: Shoreline Oil Thickness Thresholds

Shoreline Oiling Classification (ITOPF, 2014)	Thickness Threshold (mm)	Concentration	Colour
Light Oiling	0.001 - <1	0.001 – 1 litres / m^2	
Moderate Oiling	1 – 10	1 – 10 litres / m^2	
Heavy Oiling	>10	>10 litres / m^2	

B.3 Stochastic Modelling Results

B.3.1 Summary of Results

Table B.6 summarises the stochastic results for a worst case subsea well blowout in the Victory field across all seasons. The results in Table B.6 report the minimum arrival time and probability of oil to reach land and the territorial waters of nearby countries.

Table B.6: Summary of Stochastic Modelling Results

Scenario 1: Subsea Well Blowout in the Victory Field					
Spill Scenario / Descriptor: 33,000 bbl (5,247 m^3) of Condensate (85 °API) released over 60 days					
Season		Winter (December – February)	Spring (March – May)	Summer (June – August)	Autumn (September – November)
Median Crossing Note 1					
Identified Median Line	**Surface Oil: Probability and Shortest Time to Reach (Minimum Thickness of 0.3 µm)**				
Norway	*Maximum Probability*	7 %	5 %	7 %	9 %
	Shortest Arrival Time	135 hrs	182 hrs	176 hrs	186 hrs
Faroe Islands	*Maximum Probability*	3 %	5 %	2 %	1 %
	Shortest Arrival Time	149 hrs	292 hrs	119 hrs	308 hrs
Identified Median Line	**Subsurface Oil: Probability and Shortest Time to Reach (Minimum Water Column Concentration 1.0 ppb)**				
Norway	*Maximum Probability*	8 %	6 %	8 %	16 %
	Shortest Arrival Time	240 hrs	209 hrs	212 hrs	232 hrs
Faroe Islands	*Maximum Probability*	1 %	6 %	4 %	1 %
	Shortest Arrival Time	946 hrs	488 hrs	177 hrs	955 hrs

Landfall [Note 1]					
Predicted Locations	**Shoreline Oil: Probability and Shortest Time to Reach (Minimum Thickness of 1.0 µm)**				
Norway	*Maximum Probability*	1 %	N/A	N/A	1 %
	Shortest Arrival Time	426 hrs	N/A	N/A	1,011 hrs
Shetland Islands	*Maximum Probability*	23 %	10 %	5 %	28 %
	Shortest Arrival Time	50 hrs	135 hrs	257 hrs	86 hrs
Locations in Shetland:					
Mainland Shetland	*Maximum Probability*	19 %	6 %	3 %	22 %
	Shortest Arrival Time	57 hrs	135 hrs	337 hrs	212 hrs
Foula	*Maximum Probability*	3 %	N/A	N/A	6 %
	Shortest Arrival Time	129 hrs	N/A	N/A	261 hrs
Papa Stour	*Maximum Probability*	9 %	1 %	N/A	7 %
	Shortest Arrival Time	73 hrs	401 hrs	N/A	240 hrs
Out Skerries	*Maximum Probability*	1 %	1 %	N/A	2 %
	Shortest Arrival Time	692 hrs	463 hrs	N/A	412 hrs
Fetlar	*Maximum Probability*	1 %	2 %	N/A	1 %
	Shortest Arrival Time	1,642 hrs	364 hrs	N/A	999 hrs
Unst	*Maximum Probability*	18 %	9 %	5 %	28 %
	Shortest Arrival Time	102 hrs	145 hrs	303 hrs	86 hrs
Yell	*Maximum Probability*	23 %	10 %	5 %	27 %
	Shortest Arrival Time	50 hrs	283 hrs	257 hrs	87 hrs

Muckle Roe	*Maximum Probability*	N/A	N/A	N/A	6 %
	Shortest Arrival Time	N/A	N/A	N/A	261 hrs
Scalloway Islands	*Maximum Probability*	N/A	N/A	N/A	1 %
	Shortest Arrival Time	N/A	N/A	N/A	1,133 hrs
Bressay	*Maximum Probability*	1 %	N/A	N/A	N/A
	Shortest Arrival Time	1,542 hrs	N/A	N/A	N/A
Vaila	*Maximum Probability*	2 %	N/A	N/A	1 %
	Shortest Arrival Time	117 hrs	N/A	N/A	1,134 hrs
Vementry	*Maximum Probability*	N/A	N/A	N/A	4 %
	Shortest Arrival Time	N/A	N/A	N/A	245 hrs
Worst Case Trajectory Simulations Identified from Stochastic Results					
Greatest Volume of Oil Beached (in any one location)	*Trajectory Run No. (out of 100)*	67	33	10	89
	m^3	5.3	0.4	0.1	4.8
	bbl	33.33	2.52	0.63	30.19
	Tonnes	3.47416	0.27383	0.09400	3.11705
	Sim Start Date	05/12/2016	29/04/2008	07/08/2012	19/11/2016
	Sim Start Time	18:00	03:00	15:00	16:00
	Time (hrs) to Impact	665 hrs	1,045 hrs	1,496 hrs	153 hrs

Note 1: Shortest arrival time and maximum probability values are not necessarily linked to the same run. The results represent a worst case scenario for each feature based on the analysis of all model runs.

B.3.2 Stochastic Maps

The stochastic results for a worst case subsea well blowout in the Victory field were calculated from a total of 400 trajectory runs (100 simulations per season). The well blowout scenario involves the release of 33,000 bbl (5,247 m^3) of condensate (85 °API) over a 60 day period. The model is simulated for an additional 10 days following cessation of the blowout.

The stochastic model analysis used a 1 km x 1 km grid cell size. Therefore, the mapped stochastic output is shown at a 1 km^2 resolution. The following maps are presented using the WGS84 coordinate system:

Sea Surface

- **Figure B.3** - Probability of oil reaching surface cells.
- **Figure B.4** - Minimum arrival time of oil to surface cells.
- **Figure B.5** - Maximum surface oil thickness.

Water Column

- **Figure B.6** - Probability that a water column cell could be impacted.
- **Figure B.7** - Minimum arrival time of oil to water column cells.
- **Figure B.8** - Maximum total water column oil concentration.

Shoreline

- **Figure B.9** - Probability that a shoreline cell could be impacted.
- **Figure B.10** - Minimum arrival time of oil to shoreline cells.
- **Figure B.11** - Maximum shoreline oil thickness.

Figure B.3: Probability of Oil Reaching Surface Cells

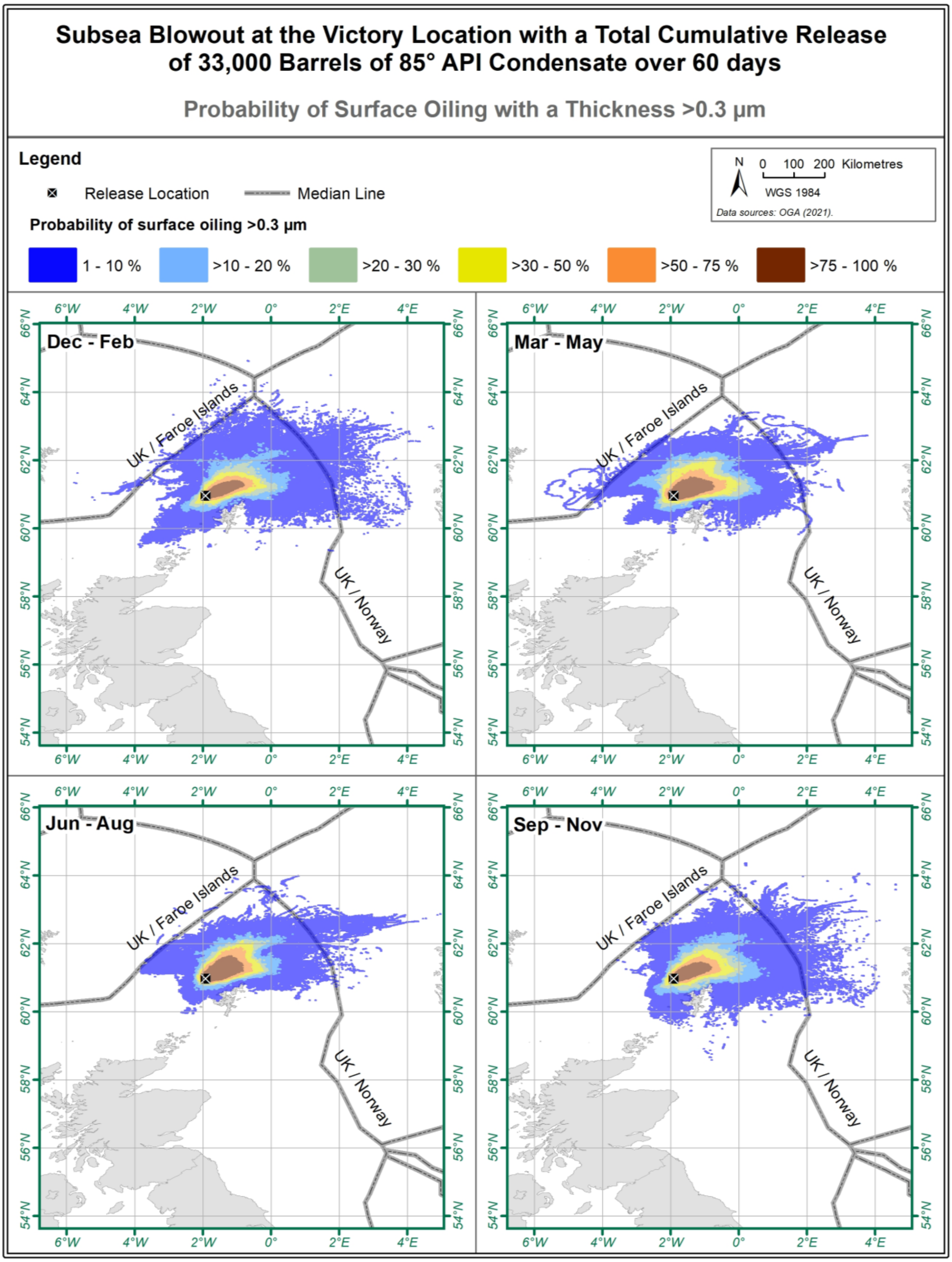


Figure B.4: Minimum Arrival Time of Oil to Surface Cells

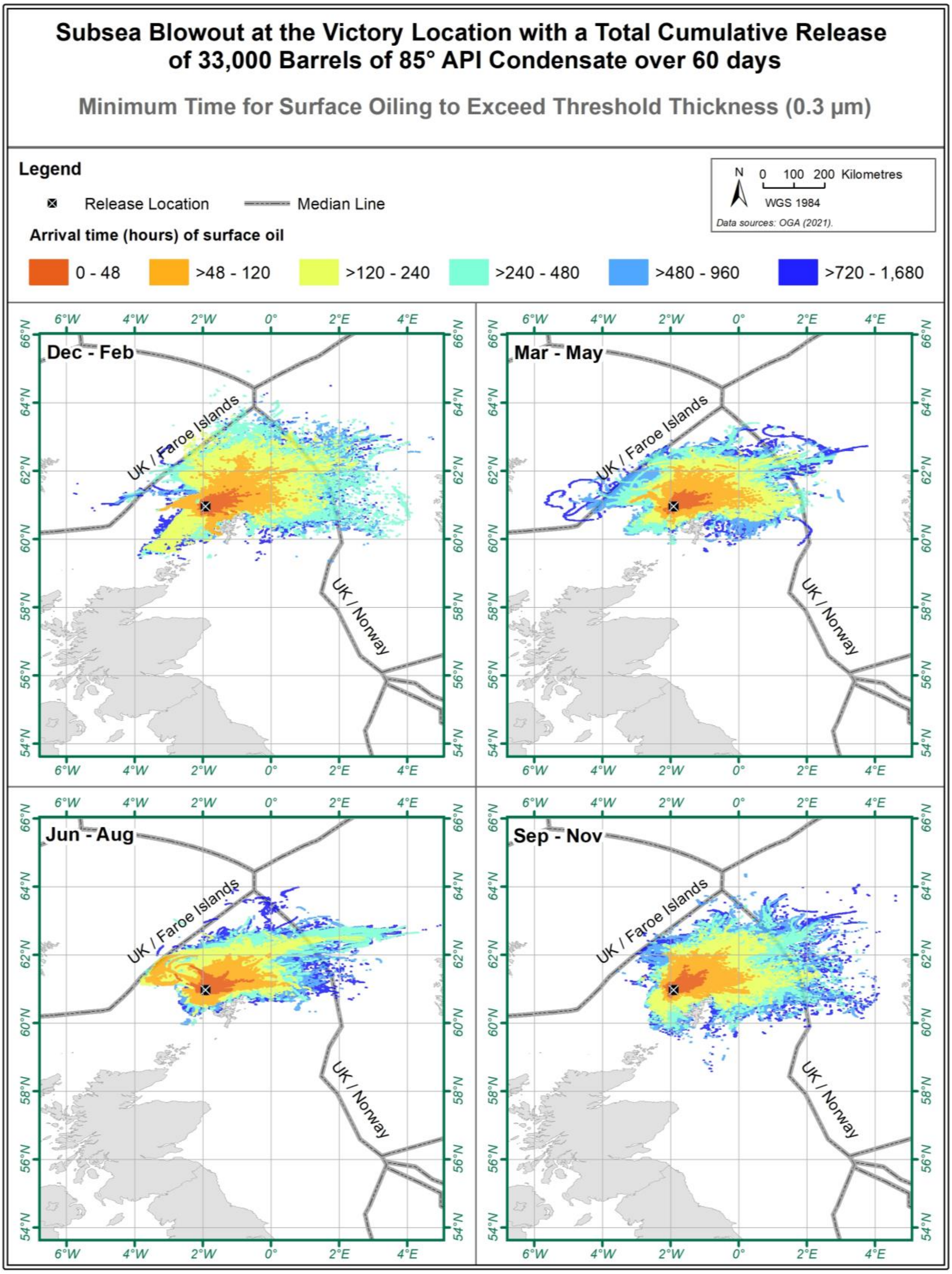


Figure B.5: Maximum Surface Oil Thickness (Bonn Code)

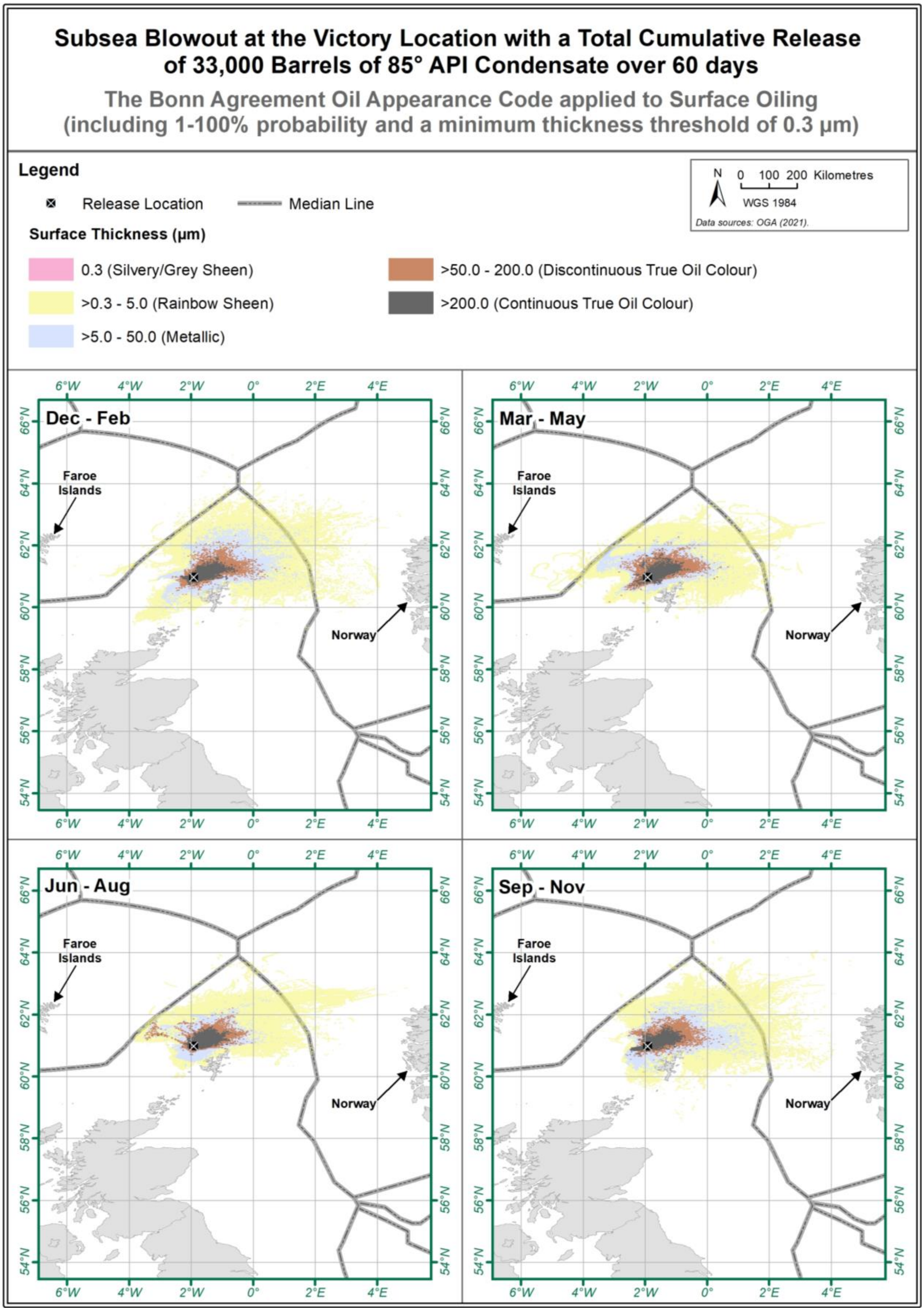


Figure B.6: Probability of Water Column Cells Impacted

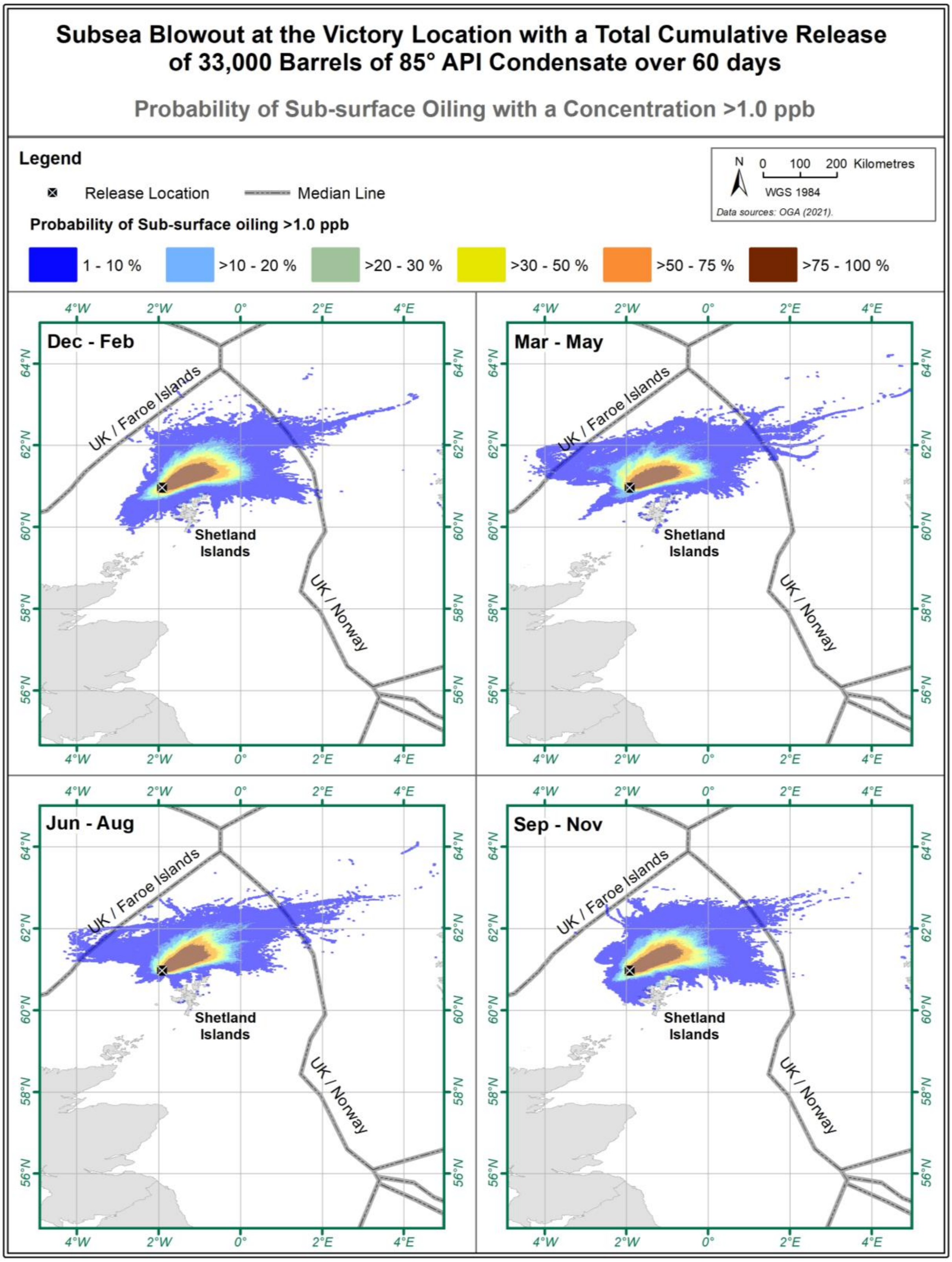


Figure B.7: Minimum Arrival Time of Oil to Water Column Cells

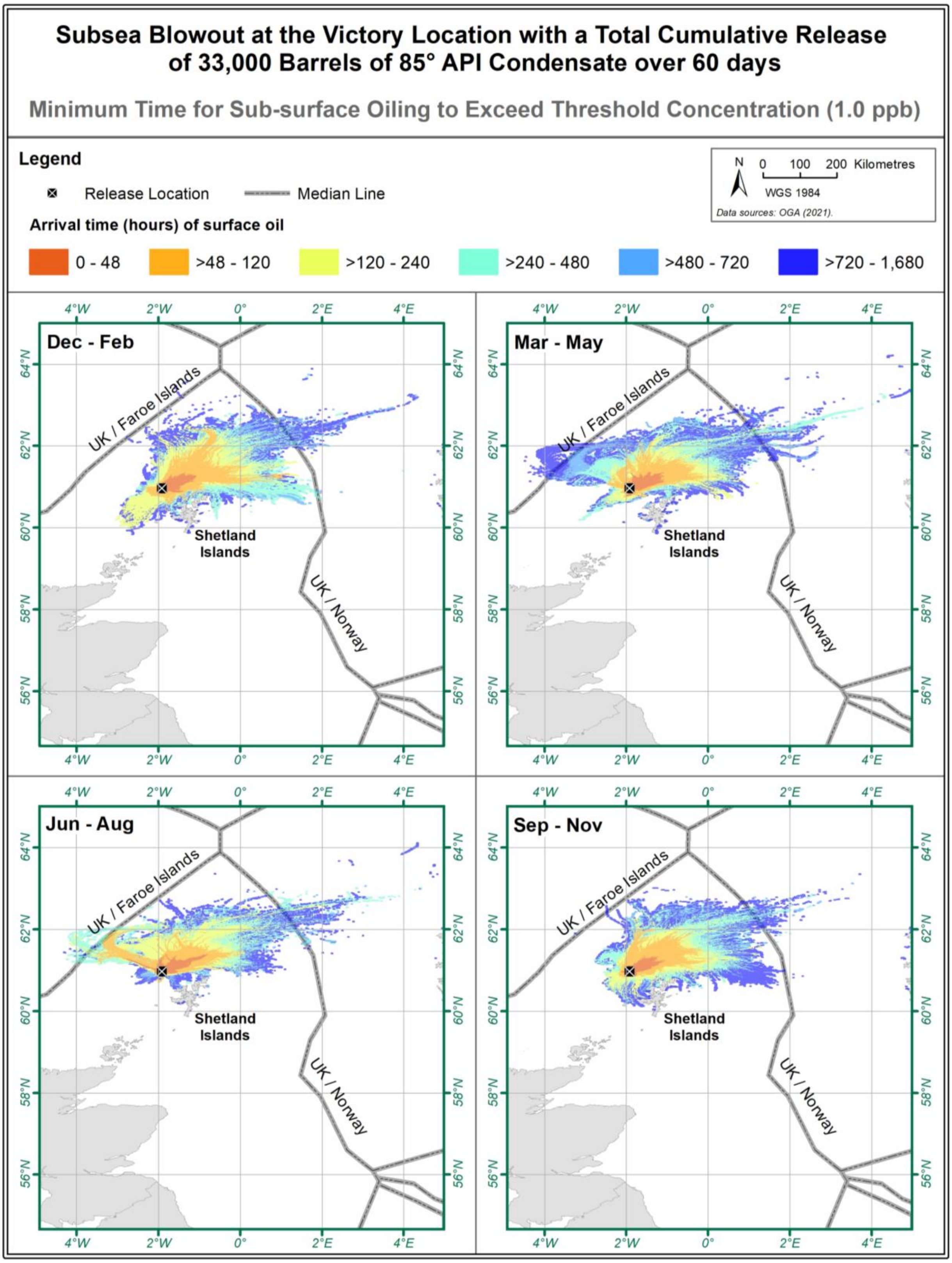


Figure B.8: Maximum Total Water Column Oil Concentrations

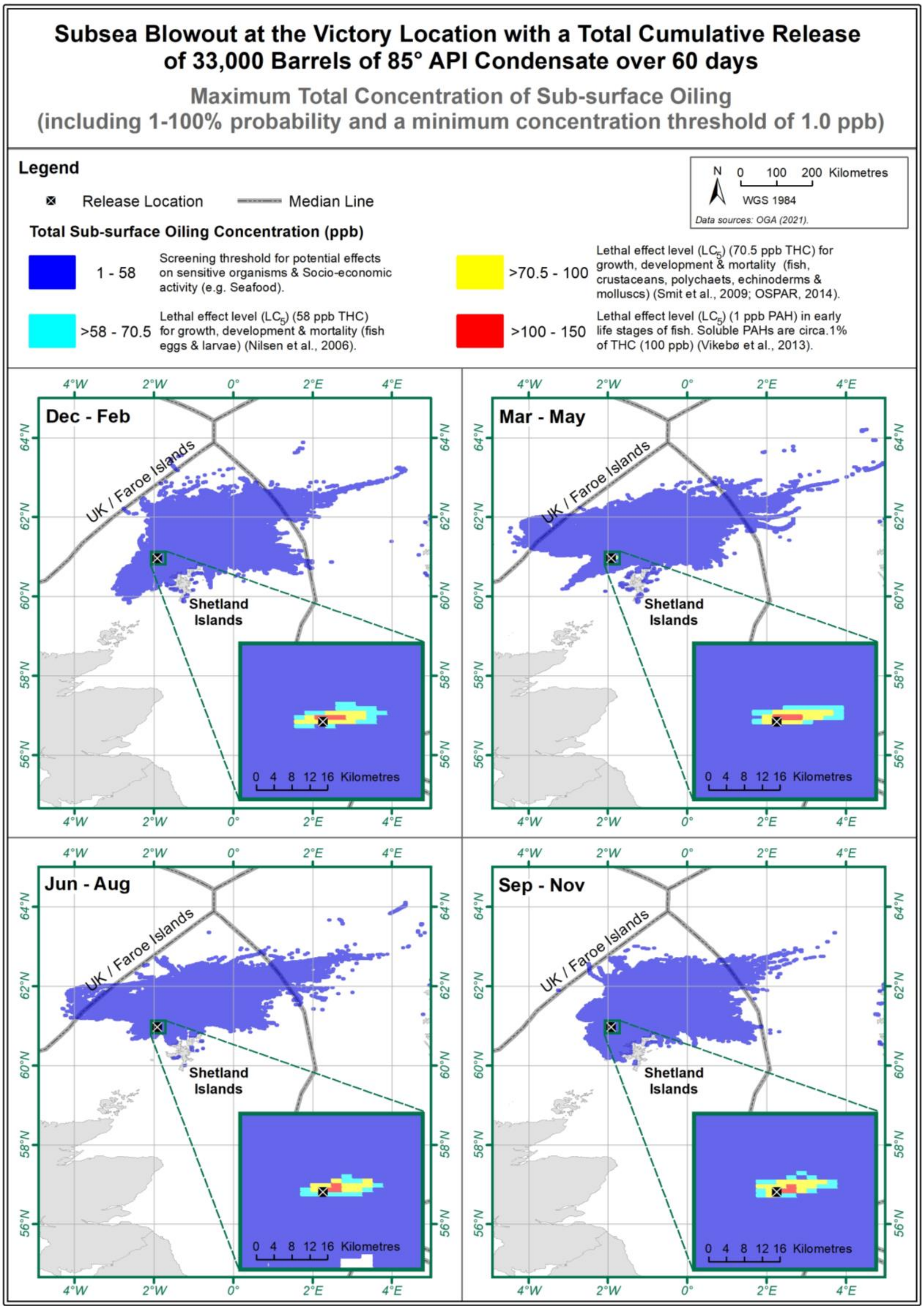


Figure B.9: Minimum Arrival Time of Oil to Shoreline Cells

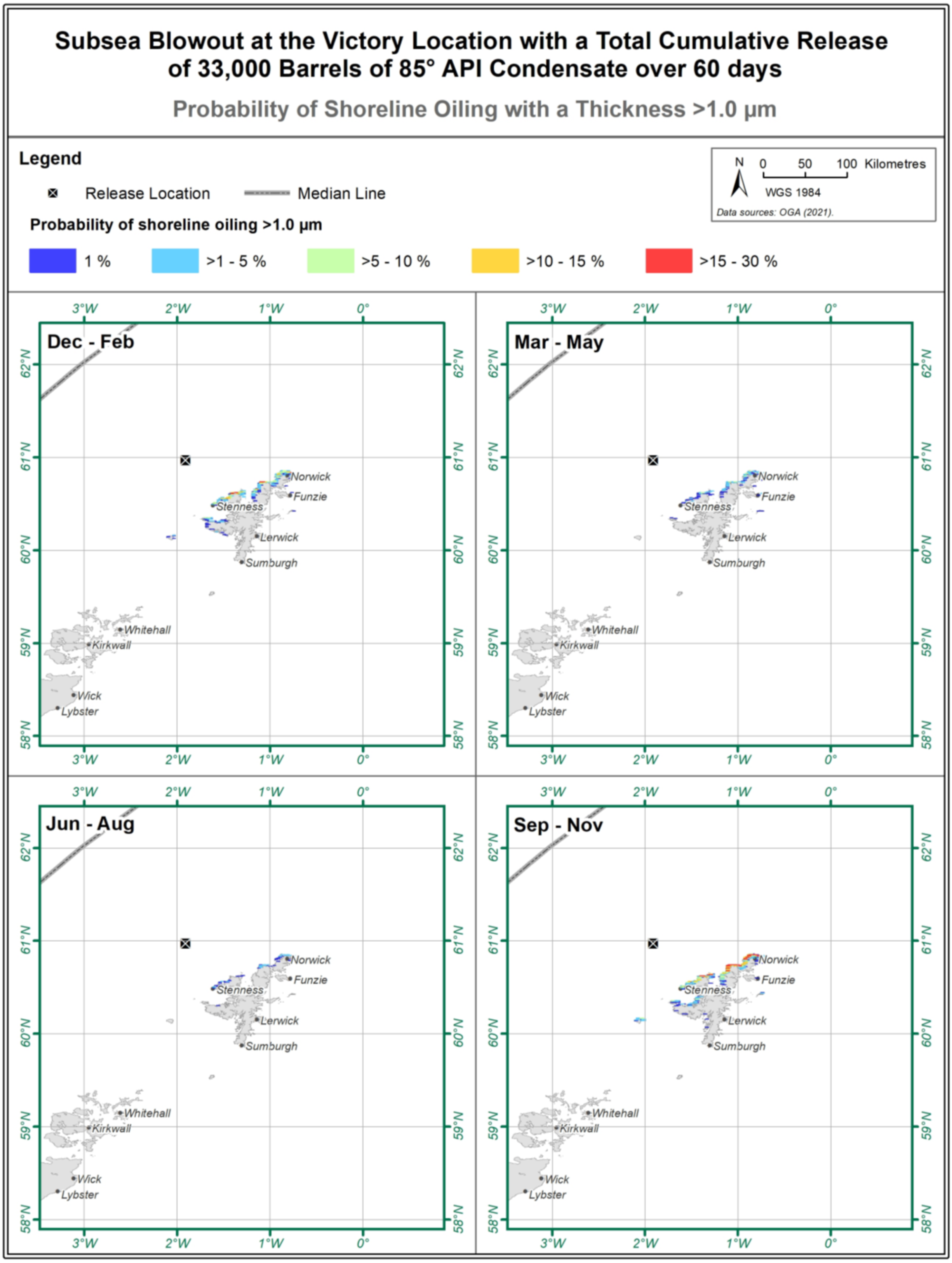


Figure B.10: Minimum Arrival Time of Oil to Shoreline Cells

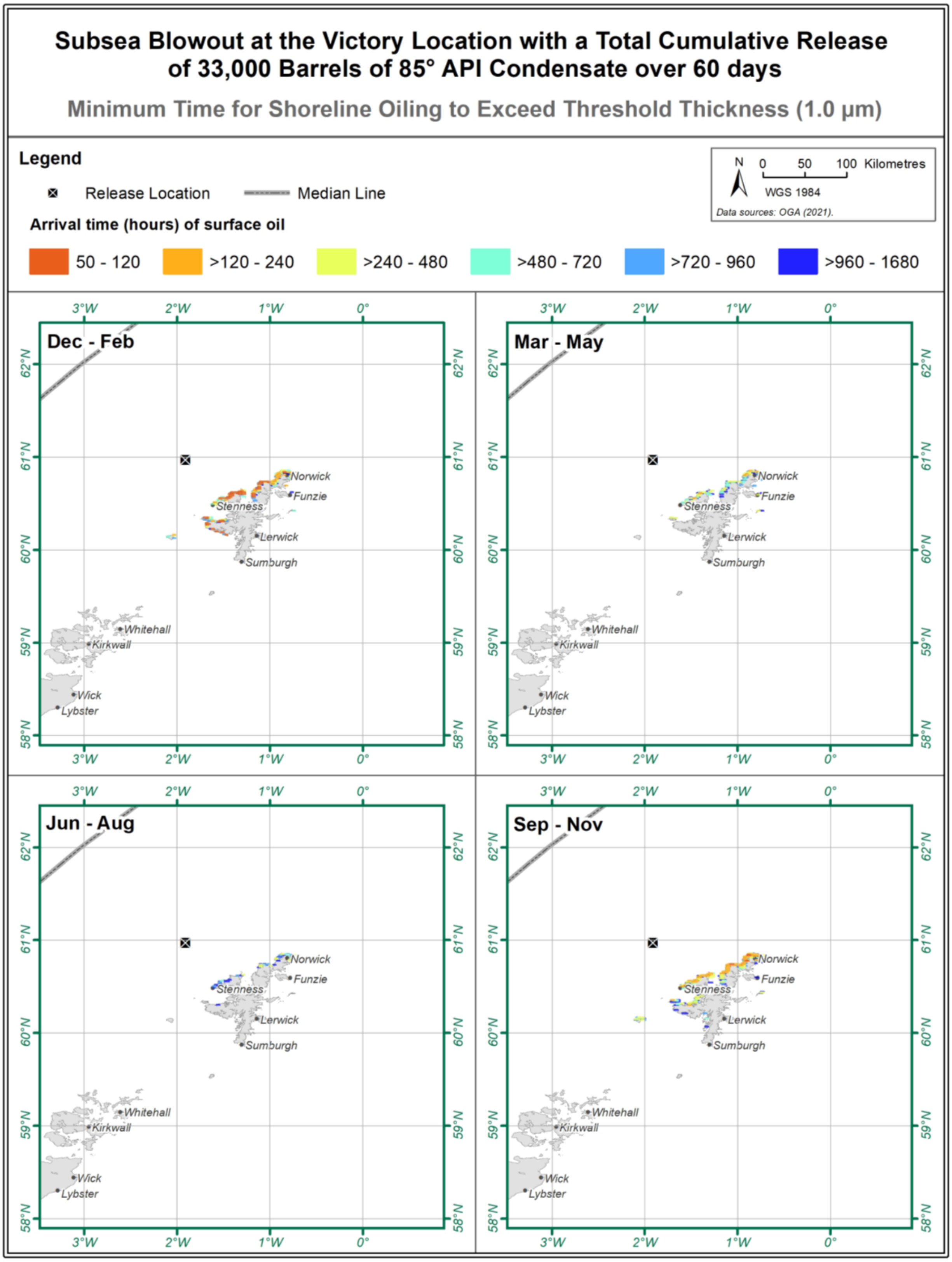
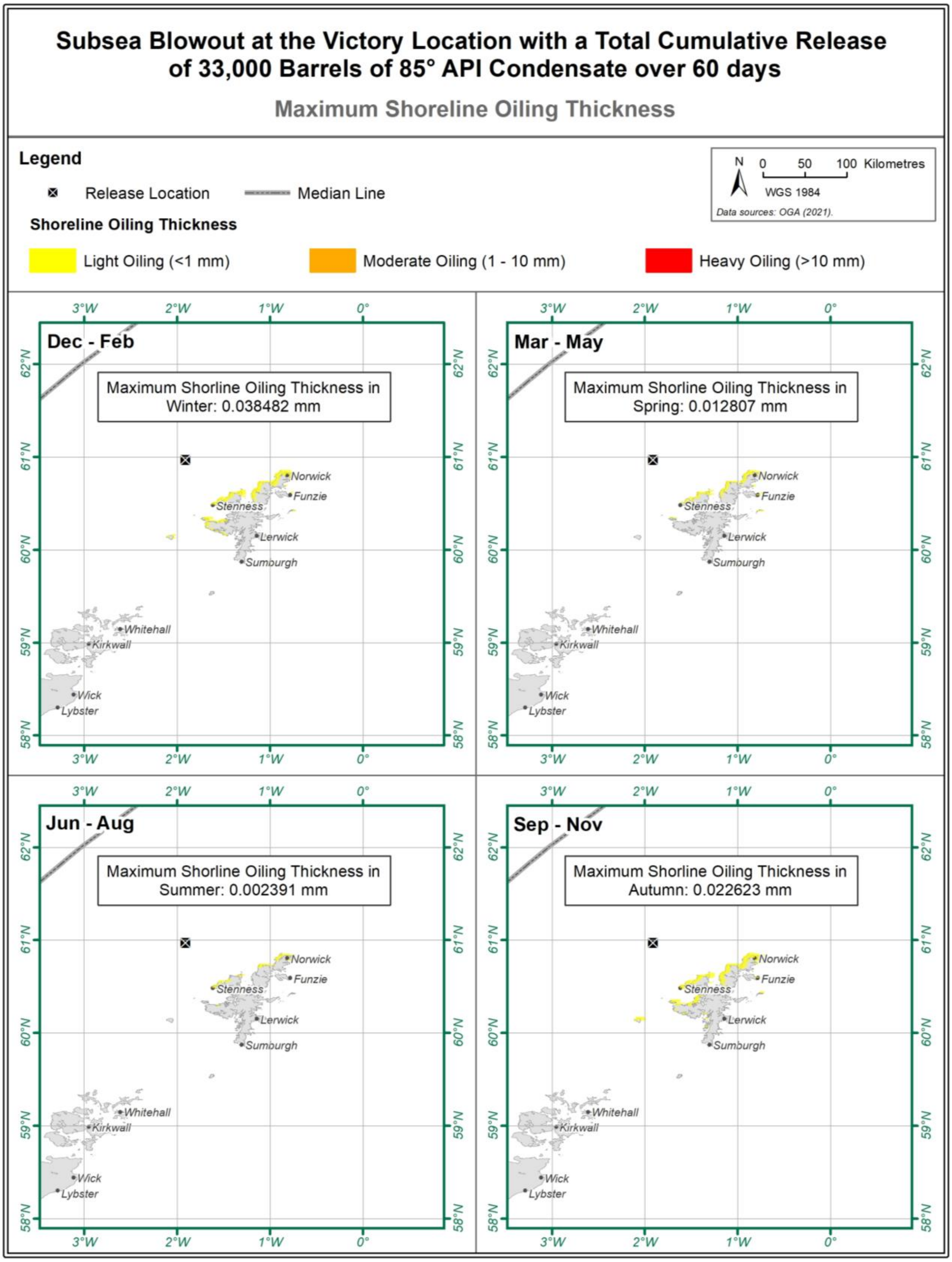


Figure B.11: Maximum Shoreline Oiling Thickness



B.3.3 Protected Areas at Risk

Stochastic Analysis for Protected Areas at Risk during Winter (Dec-Feb)

Table B.7 lists the protected areas at risk from oiling during winter. The worst case probability, minimum time and severity of oiling is reported for surface, shoreline and subsurface oil.

Table B.7: Protected Areas at Risk from Surface, Shoreline and Subsurface Oiling during Winter Note 1

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Special Protected Areas (SPA) with Marine Components									
Seas off Foula SPA	8 %	79 hrs	Bonn Code: 3 (Metallic)	N/A	N/A	N/A	6 %	180 hrs	Below LC_5 for marine fauna (<58 ppb)
Foula SPA	2 %	180 hrs	Bonn Code: 2 (Rainbow)	3 %	192 hrs	Light Oiling (0.001 – 1 litres / m^2)	1 %	739 hrs	Below LC_5 for marine fauna (<58 ppb)
Papa Stour SPA	2 %	319 hrs	Bonn Code: 2 (Rainbow)	9 %	73 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	1,089	Below LC_5 for marine fauna (<58 ppb)
East Mainland Coast, Shetland SPA	N/A	N/A	N/A	N/A	N/A	N/A	2 %	864 hrs	Below LC_5 for marine fauna (<58 ppb)

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Bluemull and Colgrave Sounds SPA	3 %	232 hrs	Bonn Code: 2 (Rainbow)	3 %	233 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Sumburgh Head SPA	N/A	N/A	N/A	N/A	N/A	N/A	1 %	1,610 hrs	Below LC_5 for marine fauna (<58 ppb)
Noss SPA	N/A	N/A	N/A	1 %	1,542 hrs	Light Oiling (0.001 – 1 litres / m^2)	1 %	1,572 hrs	Below LC_5 for marine fauna (<58 ppb)
Fetlar SPA	2 %	483 hrs	Bonn Code: 2 (Rainbow)	1 %	1,642 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	319 hrs	Below LC_5 for marine fauna (<58 ppb)
Hermaness, Saxa Vord and Valla Field SPA	11 %	80 hrs	Bonn Code: 3 (Metallic)	18 %	108 hrs	Light Oiling (0.001 – 1 litres / m^2)	19 %	158 hrs	Below LC_5 for marine fauna (<58 ppb)
Special Area of Conservation (SAC) with Marine Components									
Pobie Bank Reef SAC	8 %	115 hrs	Bonn Code: 3 (Metallic)	N/A	N/A	N/A	3 %	333 hrs	Below LC_5 for marine fauna (<58 ppb)

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Mousa SAC	N/A	N/A	N/A	N/A	N/A	N/A	1 %	1,601 hrs	Below LC_5 for marine fauna (<58 ppb)
Papa Stour SAC	4 %	78 hrs	Bonn Code: 2 (Rainbow)	9 %	73 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	1,089 hrs	Below LC_5 for marine fauna (<58 ppb)
Sullom Voe SAC	1 %	348 hrs	Bonn Code: 2 (Rainbow)	N/A	N/A	N/A	N/A	N/A	N/A
Yell Sound Coast SAC	N/A	N/A	N/A	N/A	N/A	N/A	1 %	1,344 hrs	Below LC_5 for marine fauna (<58 ppb)
RAMSAR									
Ronas Hill – North Roe and Tingon RAMSAR	8 %	98 hrs	Bonn Code: 3 (Metallic)	12 %	61 hrs	Light Oiling (0.001 – 1 litres / m^2)	21 %	325 hrs	Below LC_5 for marine fauna (<58 ppb)
Nature Conservation Marine Protected Areas (NC MPA)									
North East Faroe-Shetland Channel MPA	34 %	52 hrs	Bonn Code: 4 Discontinuous True Oil Colour	N/A	N/A	N/A	47 %	85 hrs	Below LC_5 for marine fauna (<58 ppb)

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Faroe Shetland Sponge Belt MAP	71 %	25 hrs	Bonn Code: 5 Continuous True Oil Colour	N/A	N/A	N/A	93 %	30 hrs	Below LC_5 for marine fauna (<58 ppb)
Fetlar to Haroldswick MPA	3 %	165 hrs	Bonn Code: 2 (Rainbow)	3 %	208 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	741 hrs	Below LC_5 for marine fauna (<58 ppb)
Mousa to Boddam MPA	N/A	N/A	N/A	N/A	N/A	N/A	1 %	1,601 hrs	Below LC_5 for marine fauna (<58 ppb)
North-West Orkney MPA	4 %	186 hrs	Bonn Code: 3 (Metallic)	N/A	N/A	N/A	1 %	1,237 hrs	Below LC_5 for marine fauna (<58 ppb)

Note 1: Shortest arrival time and maximum probability values are not necessarily linked to the same run. The results represent a worst case scenario for each feature based on the analysis of all model runs.

Stochastic Analysis for Protected Areas at Risk during Spring (Mar-May)

Table B.8 lists the protected areas at risk from oiling during spring. The worst case probability, minimum time and severity of oiling is reported for surface, shoreline and subsurface oil.

Table B.8: Protected Areas at Risk from Surface, Shoreline and Subsurface Oiling during Spring Note 1

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Special Protected Areas (SPA) with Marine Components									
Seas off Foula SPA	6 %	195 hrs	Bonn Code: 4 Discontinuous True Oil Colour	N/A	N/A	N/A	1 %	309 hrs	Below LC_5 for marine fauna (<58 ppb)
Foula SPA	N/A	N/A	N/A	N/A	N/A	N/A	1 %	1,643 hrs	Below LC_5 for marine fauna (<58 ppb)
Papa Stour SPA	1 %	449 hrs	Bonn Code: 2 (Rainbow)	1 %	401 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	741 hrs	Below LC_5 for marine fauna (<58 ppb)
East Mainland Coast, Shetland SPA	2 %	418 hrs	Bonn Code: 2 (Rainbow)	N/A	N/A	N/A	6 %	849 hrs	Below LC_5 for marine fauna (<58 ppb)
Bluemull and Colgrave Sounds SPA	1 %	875 hrs	Bonn Code: 2 (Rainbow)	1 %	881 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Sumburgh Head SPA	N/A	N/A	N/A	N/A	N/A	N/A	6 %	830 hrs	Below LC_5 for marine fauna (<58 ppb)
Noss SPA	N/A	N/A	N/A	N/A	N/A	N/A	7 %	792 hrs	Below LC_5 for marine fauna (<58 ppb)
Fetlar SPA	2 %	334 hrs	Bonn Code: 2 (Rainbow)	2 %	364 hrs	Light Oiling (0.001 – 1 litres / m^2)	16 %	756 hrs	Below LC_5 for marine fauna (<58 ppb)
Hermaness, Saxa Vord and Valla Field SPA	18 %	80 hrs	Bonn Code: 3 (Metallic)	9 %	145 hrs	Light Oiling (0.001 – 1 litres / m^2)	14 %	280 hrs	Below LC_5 for marine fauna (<58 ppb)
Special Area of Conservation (SAC) with Marine Components									
Pobie Bank Reef SAC	8 %	203 hrs	Bonn Code: 2 (Rainbow)	N/A	N/A	N/A	N/A	N/A	N/A
Mousa SAC	N/A	N/A	N/A	N/A	N/A	N/A	4 %	827 hrs	Below LC_5 for marine fauna (<58 ppb)

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Papa Stour SAC	1 %	448 hrs	Bonn Code: 2 (Rainbow)	1 %	401 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	648 hrs	Below LC_5 for marine fauna (<58 ppb)
Yell Sound Coast SAC	N/A	N/A	N/A	N/A	N/A	N/A	6 %	862 hrs	Below LC_5 for marine fauna (<58 ppb)
RAMSAR									
Ronas Hill – North Roe and Tingon RAMSAR	3 %	161 hrs	Bonn Code: 3 (Metallic)	1 %	162 hrs	Light Oiling (0.001 – 1 litres / m^2)	11 %	377 hrs	Below LC_5 for marine fauna (<58 ppb)
Nature Conservation Marine Protected Areas (NC MPA)									
North East Faroe-Shetland Channel MPA	67 %	53 hrs	Bonn Code: 5 Continuous True Oil Colour	N/A	N/A	N/A	63 %	61 hrs	Below LC_5 for marine fauna (<58 ppb)
Faroe Shetland Sponge Belt MAP	100 %	24 hrs	Bonn Code: 5 Continuous True Oil Colour	N/A	N/A	N/A	98 %	32 hrs	Below LC_5 for marine fauna (<58 ppb)

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Fetlar to Haroldswick MPA	2 %	234 hrs	Bonn Code: 2 (Rainbow)	2 %	245 hrs	Light Oiling (0.001 – 1 litres / m^2)	16 %	756 hrs	Below LC_5 for marine fauna (<58 ppb)
Mousa to Boddam MPA	N/A	N/A	N/A	N/A	N/A	N/A	4 %	827 hrs	Below LC_5 for marine fauna (<58 ppb)

Note 1: Shortest arrival time and maximum probability values are not necessarily linked to the same run. The results represent a worst case scenario for each feature based on the analysis of all model runs.

Stochastic Analysis for Protected Areas at Risk during Summer (Jun-Aug)

Table B.9 lists the protected areas at risk from oiling during summer. The worst case probability, minimum time and severity of oiling is reported for surface, shoreline and subsurface oil.

Table B.9: Protected Areas at Risk from Surface, Shoreline and Subsurface Oiling during Summer Note 1

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Special Protected Areas (SPA) with Marine Components									
Seas off Foula SPA	3 %	139 hrs	Bonn Code: 3 (Metallic)	N/A	N/A	N/A	N/A	N/A	N/A
East Mainland Coast, Shetland SPA	N/A	N/A	N/A	N/A	N/A	N/A	2 %	432 hrs	Below LC_5 for marine fauna (<58 ppb)
Fetlar SPA	N/A	N/A	N/A	N/A	N/A	N/A	2 %	494 hrs	Below LC_5 for marine fauna (<58 ppb)
Hermaness, Saxa Vord and Valla Field SPA	6 %	183 hrs	Bonn Code: 4 Discontinuous True Oil Colour	5 %	306 hrs	Light Oiling (0.001 – 1 litres / m^2)	5 %	357 hrs	Below LC_5 for marine fauna (<58 ppb)
Special Area of Conservation (SAC) with Marine Components									
Pobie Bank Reef SAC	3 %	188 hrs	Bonn Code: 2 (Rainbow)	N/A	N/A	N/A	N/A	N/A	N/A

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Yell Sound Coast SAC	N/A	N/A	N/A	N/A	N/A	N/A	2 %	432 hrs	Below LC_5 for marine fauna (<58 ppb)
RAMSAR									
Ronas Hill – North Roe and Tingon RAMSAR	3 %	535 hrs	Bonn Code: 2 (Rainbow)	2 %	1,110 hrs	Light Oiling (0.001 – 1 litres / m^2)	5 %	566 hrs	Below LC_5 for marine fauna (<58 ppb)
Nature Conservation Marine Protected Areas (NC MPA)									
North East Faroe-Shetland Channel MPA	79 %	39 hrs	Bonn Code: 5 Continuous True Oil Colour	N/A	N/A	N/A	59 %	55 hrs	Below LC_5 for marine fauna (<58 ppb)
Faroe Shetland Sponge Belt MAP	100 %	19 hrs	Bonn Code: 5 Continuous True Oil Colour	N/A	N/A	N/A	99 %	26 hrs	Below LC_5 for marine fauna (<58 ppb)
Fetlar to Haroldswick MPA	1 %	356 hrs	Bonn Code: 2 (Rainbow)	1 %	357 hrs	Light Oiling (0.001 – 1 litres / m^2)	2 %	494 hrs	Below LC_5 for marine fauna (<58 ppb)

Note 1: Shortest arrival time and maximum probability values are not necessarily linked to the same run. The results represent a worst case scenario for each feature based on the analysis of all model runs.

Stochastic Analysis for Protected Areas at Risk during Autumn (Sep-Nov)

Table B.10 lists the protected areas at risk from oiling during autumn. The worst case probability, minimum time and severity of oiling is reported for surface, shoreline and subsurface oil.

Table B.10: Protected Areas at Risk from Surface, Shoreline and Subsurface Oiling during Autumn Note 1

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Special Protected Areas (SPA) with Marine Components									
Seas off Foula SPA	6 %	185 hrs	Bonn Code: 3 (Metallic)	N/A	N/A	N/A	3 %	239 hrs	Below LC_5 for marine fauna (<58 ppb)
Foula SPA	5 %	234 hrs	Bonn Code: 2 (Rainbow)	6 %	261 hrs	Light Oiling (0.001 – 1 litres / m^2)	1 %	680 hrs	Below LC_5 for marine fauna (<58 ppb)
Papa Stour SPA	1 %	228 hrs	Bonn Code: 2 (Rainbow)	7 %	240 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	227 hrs	Below LC_5 for marine fauna (<58 ppb)
East Mainland Coast, Shetland SPA	1 %	1,131 hrs	Bonn Code: 2 (Rainbow)	N/A	N/A	N/A	N/A	N/A	N/A
Bluemull and Colgrave Sounds SPA	11 %	364 hrs	Bonn Code: 2 (Rainbow)	7 %	366 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
Fetlar SPA	2 %	226 hrs	Bonn Code: 2 (Rainbow)	1 %	999 hrs	Light Oiling (0.001 – 1 litres / m^2)	7 %	909 hrs	Below LC_5 for marine fauna (<58 ppb)
Hermaness, Saxa Vord and Valla Field SPA	25 %	80 hrs	Bonn Code: 4 Discontinuous True Oil Colour	28 %	86 hrs	Light Oiling (0.001 – 1 litres / m^2)	38 %	219 hrs	Below LC_5 for marine fauna (<58 ppb)
Special Area of Conservation (SAC) with Marine Components									
Pobie Bank Reef SAC	10 %	97 hrs	Bonn Code: 3 (Metallic)	N/A	N/A	N/A	3 %	264 hrs	Below LC_5 for marine fauna (<58 ppb)
Papa Stour SAC	5 %	228 hrs	Bonn Code: 3 (Metallic)	7 %	240 hrs	Light Oiling (0.001 – 1 litres / m^2)	4 %	226 hrs	Below LC_5 for marine fauna (<58 ppb)
Sullom Voe SAC	1 %	621 hrs	Bonn Code: 2 (Rainbow)	1 %	630 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A
Yell Sound Coast SAC	2 %	439 hrs	Bonn Code: 2 (Rainbow)	1 %	1,346 hrs	Light Oiling (0.001 – 1 litres / m^2)	N/A	N/A	N/A

Protected Area	Surface Oil (Minimum Thickness of 0.3 µm)			Shoreline Oil (Minimum Thickness of 1.0 µm)			Subsurface Oil (Minimum Water Column Concentration 1.0 ppb)		
	Maximum Probability	Shortest Arrival Time	Maximum Severity of Surface Oiling (refer to Table B.3)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Shoreline Oiling (refer to Table B.5)	Maximum Probability	Shortest Arrival Time	Maximum Severity of Water Column Oiling (refer to Table B.4)
RAMSAR									
Ronas Hill – North Roe and Tingon RAMSAR	9 %	211 hrs	Bonn Code: 3 (Metallic)	14 %	212 hrs	Light Oiling (0.001 – 1 litres / m^2)	26 %	297 hrs	Below LC_5 for marine fauna (<58 ppb)
Nature Conservation Marine Protected Areas (NC MPA)									
North East Faroe-Shetland Channel MPA	42 %	45 hrs	Bonn Code: 5 Continuous True Oil Colour	N/A	N/A	N/A	51 %	75 hrs	Below LC_5 for marine fauna (<58 ppb)
Faroe Shetland Sponge Belt MAP	83 %	25 hrs	Bonn Code: 5 Continuous True Oil Colour	N/A	N/A	N/A	93 %	43 hrs	Below LC_5 for marine fauna (<58 ppb)
Fetlar to Haroldswick MPA	11 %	185 hrs	Bonn Code: 2 (Rainbow)	7 %	187 hrs	Light Oiling (0.001 – 1 litres / m^2)	7 %	909 hrs	Below LC_5 for marine fauna (<58 ppb)
North-West Orkney MPA	2 %	467 hrs	Bonn Code: 2 (Rainbow)	N/A	N/A	N/A	N/A	N/A	N/A

Note 1: Shortest arrival time and maximum probability values are not necessarily linked to the same run. The results represent a worst case scenario for each feature based on the analysis of all model runs.

B.4 Trajectory Modelling Results

The stochastic modelling results detailed above in Section B.3 were composed of 100 individual trajectory simulations per season. The worst case trajectory simulation for each season has been extracted to produce a fates analysis for the duration of the spill plus 10 days (total 70 days model duration).

The worst case trajectory simulations have been identified by the 'greatest mass of beached condensate at any one location'. The following trajectory simulations have been extracted and analysed:

- **Winter (Dec-Feb):** Run No. 67 (Start Date: 05/12/2016; Start Time: 18:00), 3.47 tonnes (33.33 bbl or 5.3 m^3) of condensate beached.
- **Spring (Mar-May):** Run No. 33 (Start Date: 29/04/2008; Start Time: 03:00), 0.27 tonnes (2.52 bbl or 0.4 m^3) of condensate beached.
- **Summer (Jun-Aug):** Run No. 10 (Start Date: 07/08/2012; Start Time: 15:00), 0.09 tonnes (0.63 bbl or 0.1 m^3) of condensate beached.
- **Autumn (Sep-Nov):** Run No. 89 (Start Date: 19/11/2016; Start Time: 16:00), 3.12 tonnes (30.19 bbl or 4.8 m^3) of condensate beached.

Figure B.12 displays the trajectory simulations spatially, with total swept area of surface and shoreline oiling at 24 hour time steps after 70 days. Table B.11 provides summary statistics for the trajectory simulations. The fate of the released condensate is consistent between seasons with the majority evaporated and degraded after 70 days. The winter and autumn simulations produce the greatest impact on the shoreline.

Table B.11: Fate Analysis Summary for Trajectory Simulations

Season	Trajectory Run No.	Minimum Time for Surface Oiling	Maximum Surface Slick Area	Minimum Time for Shoreline Oiling	Impacted Length of Coastline after 70 days	Fate of Released Condensate after 70 days (% of total release) Note 1					
						Ashore	Surface	Water Column	Evaporated	Degraded	Sediment
Winter	67	16 hrs	17 km^2	665 hrs	39.88 km	0.09	0.0	2.14	70.67	27.10	0.0
Spring	33	15 hrs	18 km^2	1,045 hrs	5.66 km	0.01	0.0	2.10	72.11	25.78	0.0
Summer	10	14 hrs	18.5 km^2	1,496 hrs	3.17 km	0.0	0.0	2.11	72.41	25.48	0.0
Autumn	89	15 hrs	20 km^2	153 hrs	37.04 km	0.08	0.0	2.09	72.03	25.80	0.0

Note 1: Refer to fates analysis graphs (**Winter**: Figure B.13 & Figure B.14; **Spring**: Figure B.15 & Figure B.16; **Summer**: Figure B.17 & Figure B.18; **Autumn**: Figure B.19 & Figure B.20)

Figure B.12: Worst Case Trajectory Simulations Showing Swept Area for Surface and Shoreline Oiling at 24 hour Intervals

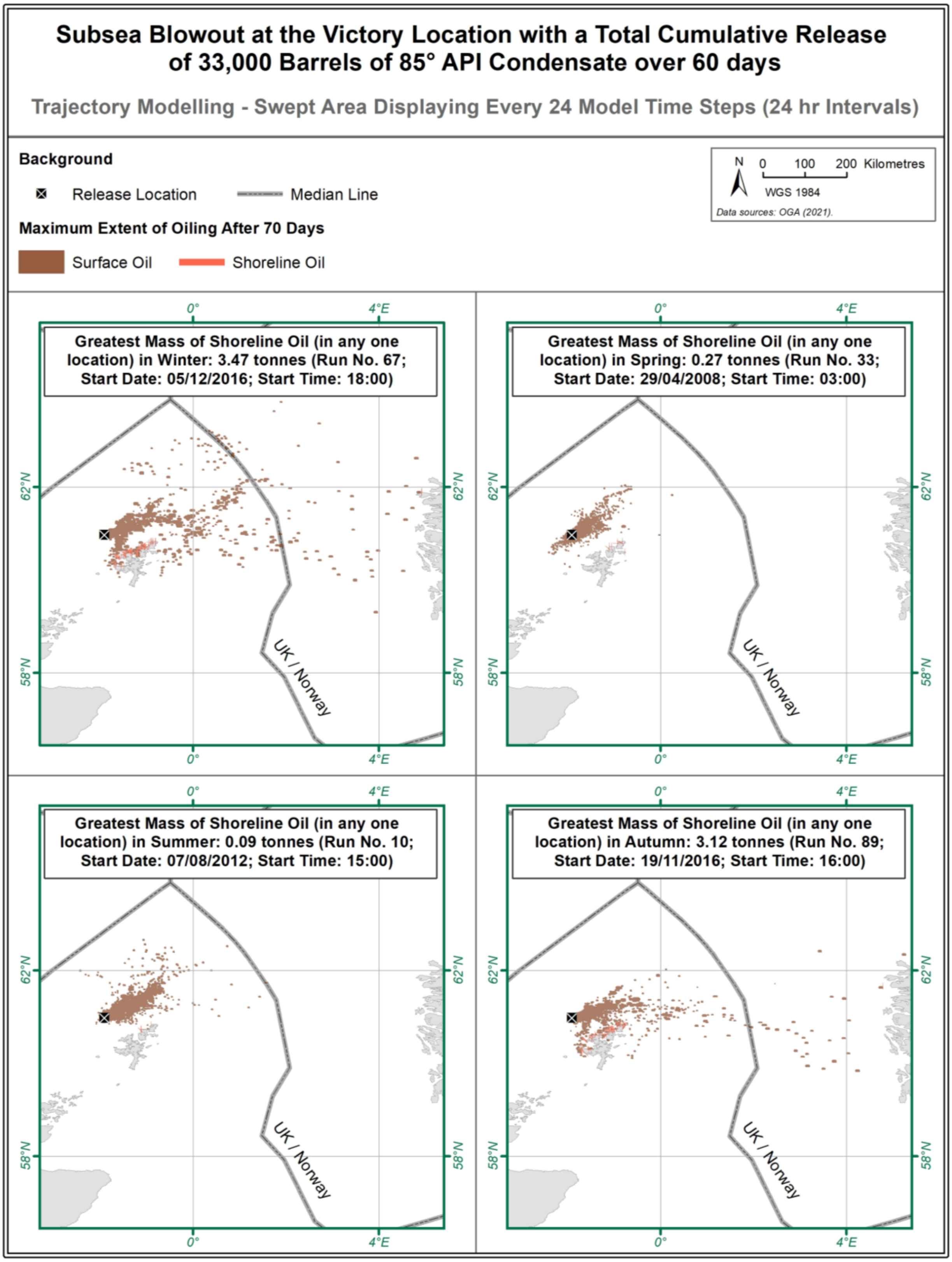


Figure B.13: Fate of the condensate released from Winter Run No. 67 (showing model duration 70 days)

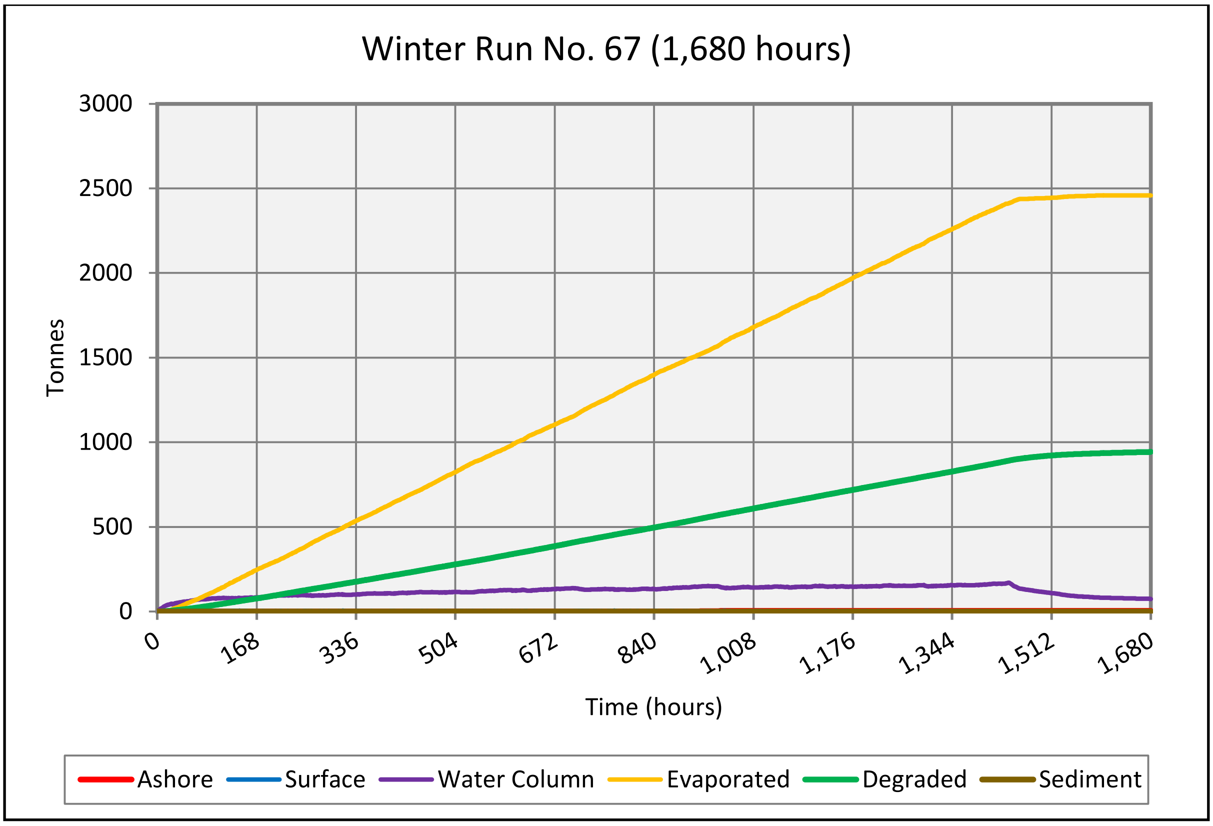


Figure B.14: Fate of the condensate released from Winter Run No. 67 (showing first week of release)

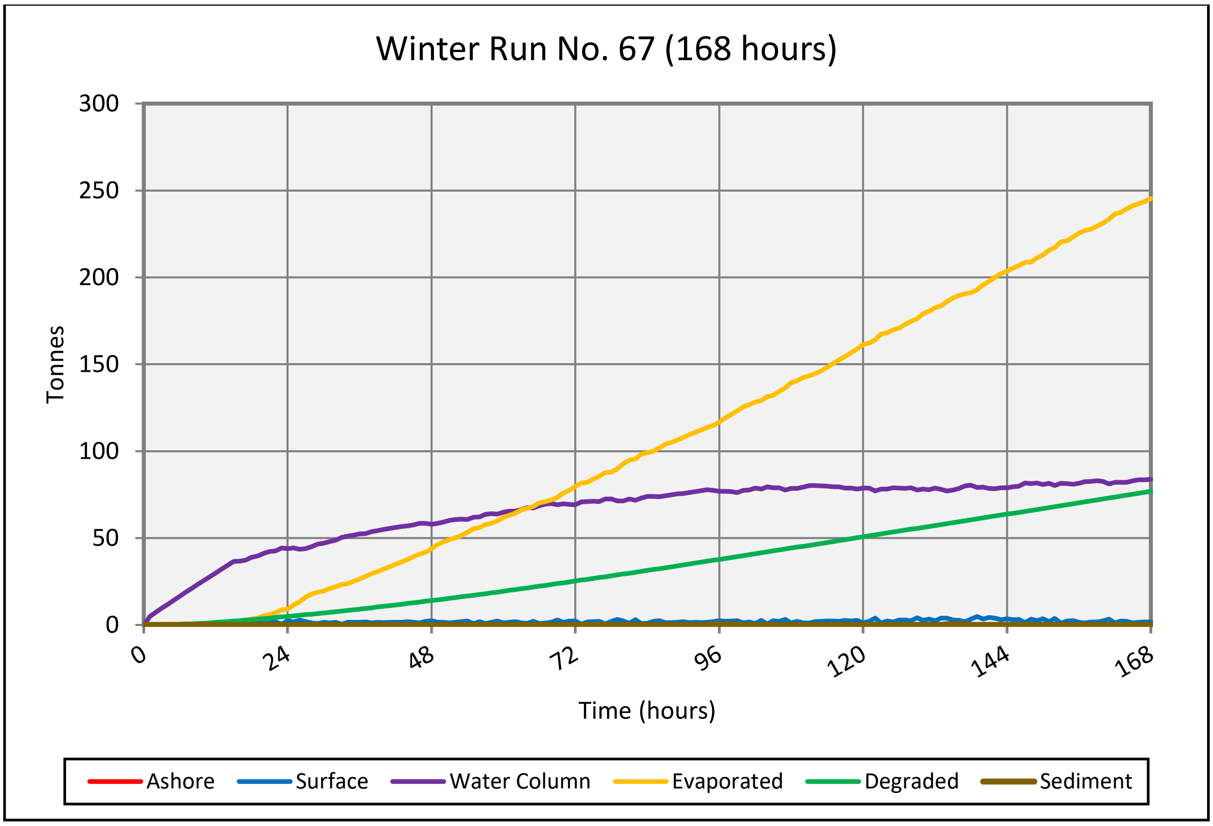


Figure B.15: Fate of the condensate released from Spring Run No. 33 (showing model duration 70 days)

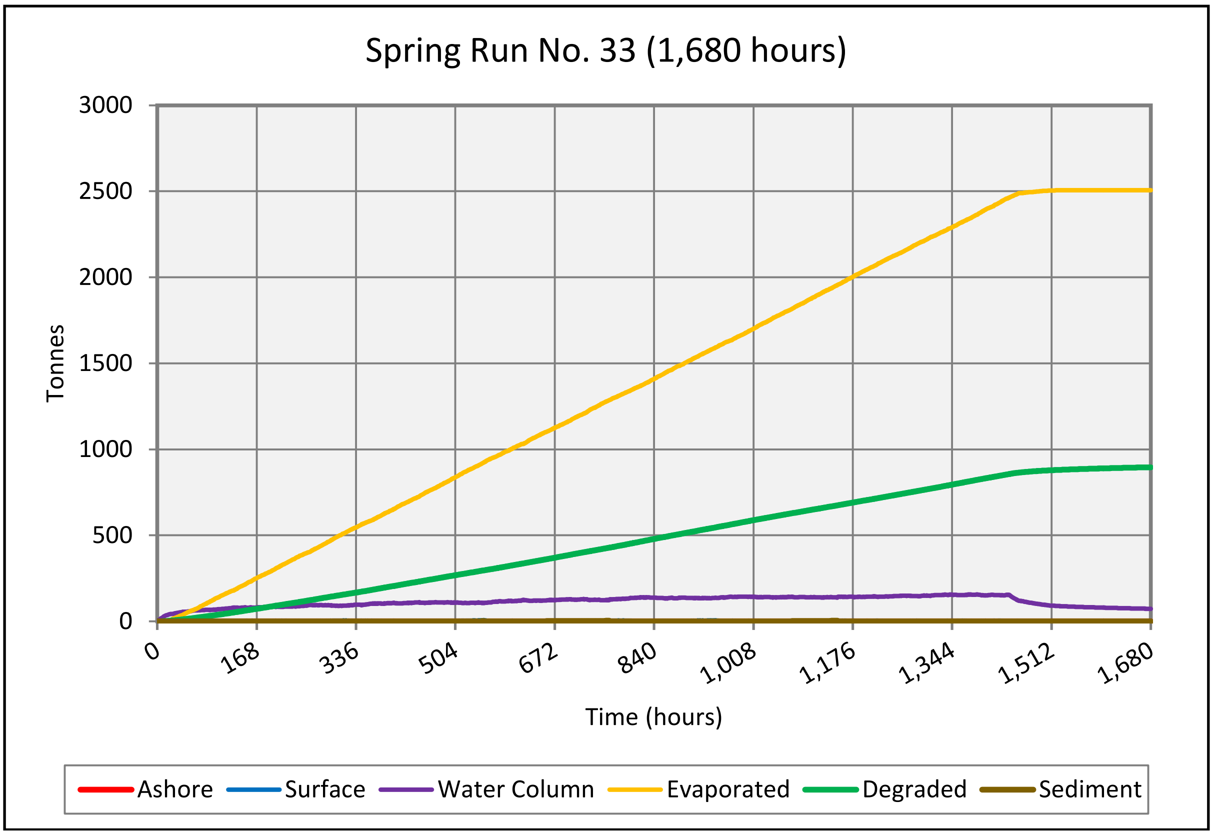


Figure B.16: Fate of the condensate released from Spring Run No. 33 (showing first week of release)

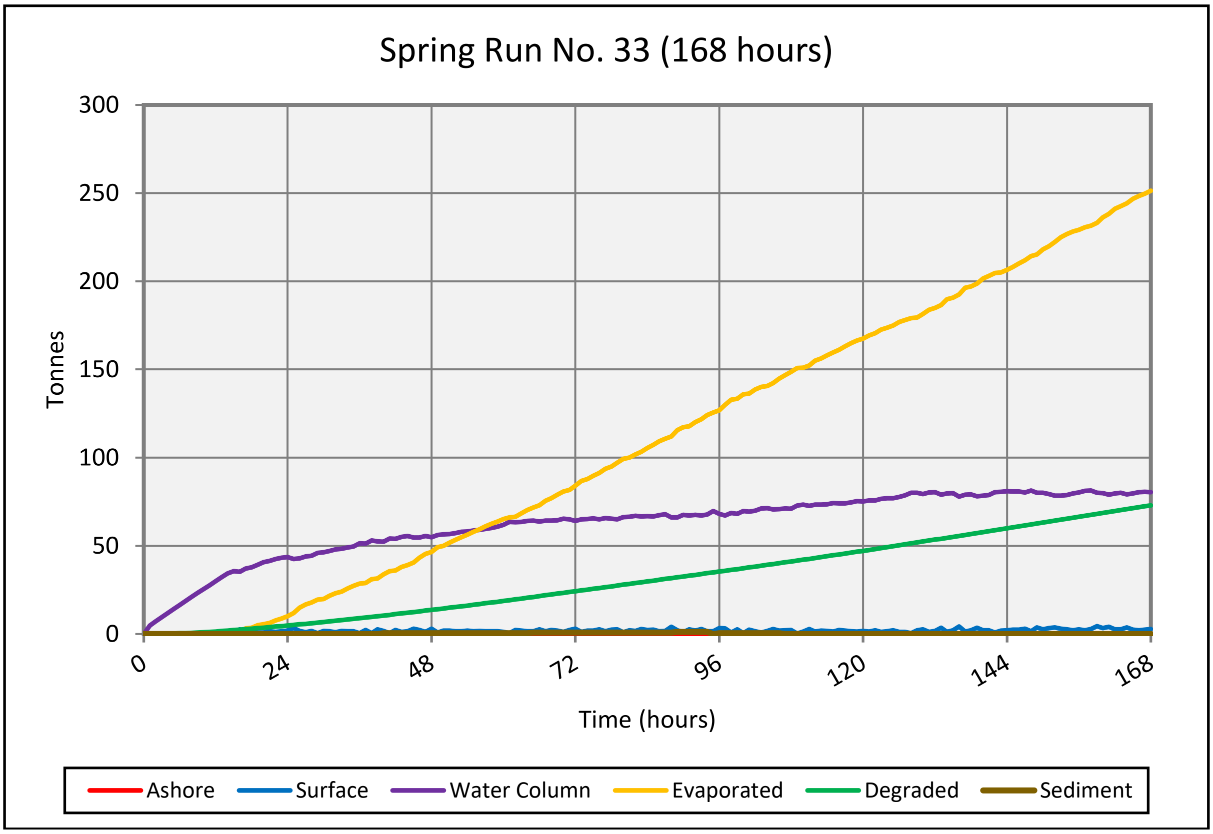


Figure B.17: Fate of the condensate released from Summer Run No. 10 (showing model duration 70 days)

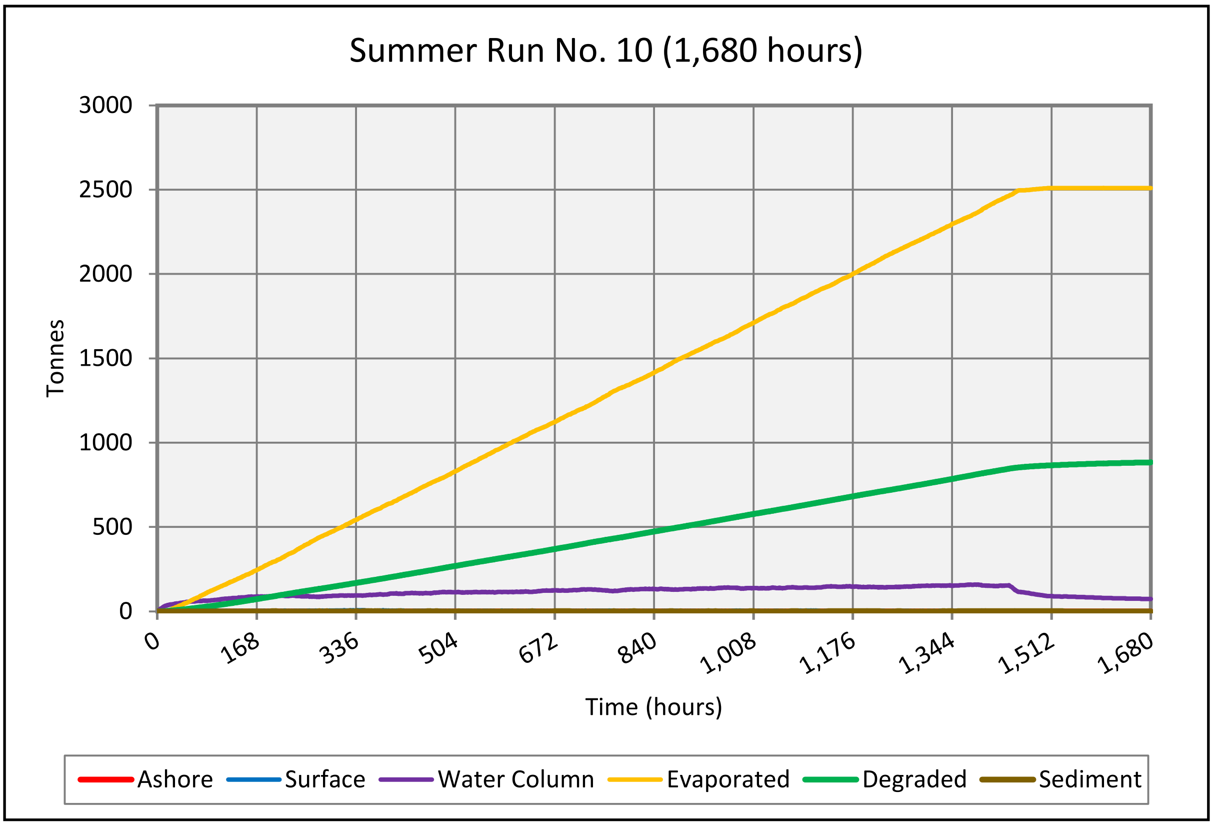


Figure B.18: Fate of the condensate released from Summer Run No. 10 (showing first week of release)

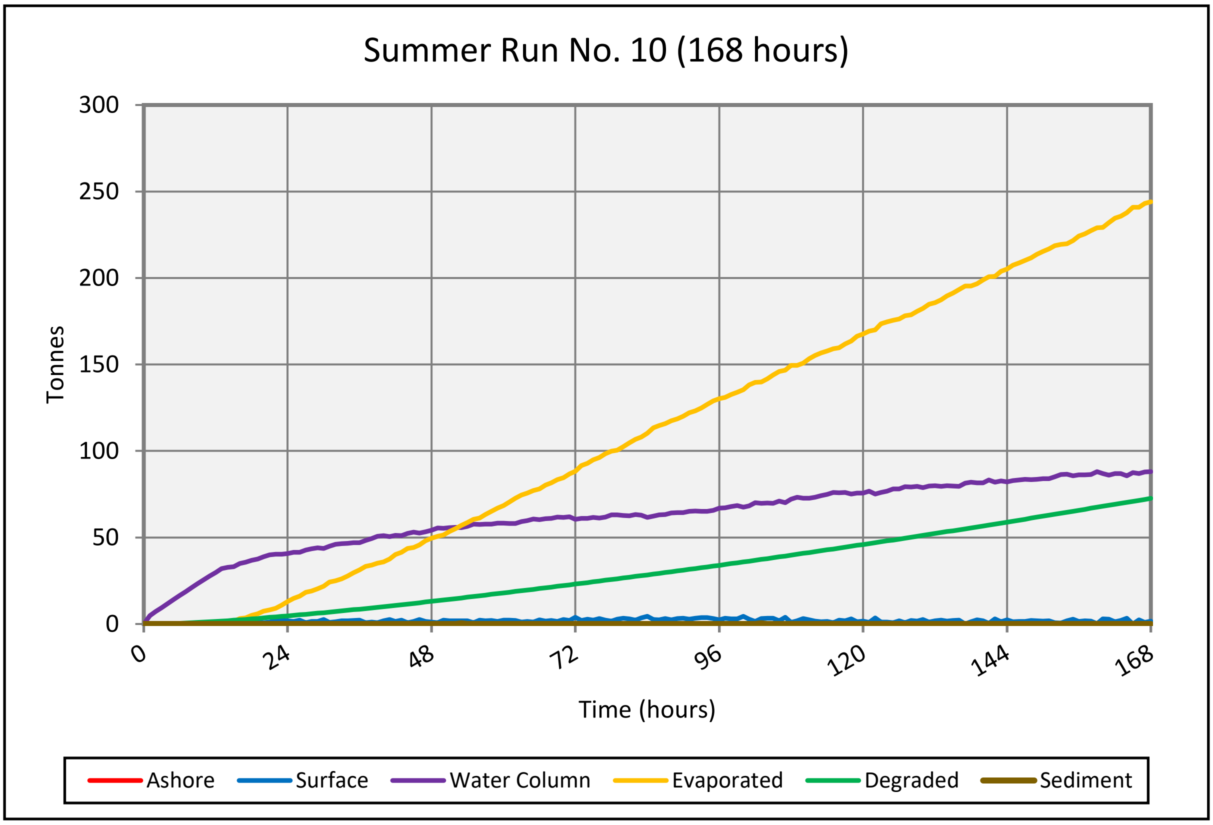


Figure B.19: Fate of the condensate released from Autumn Run No. 89 (showing model duration 70 days)

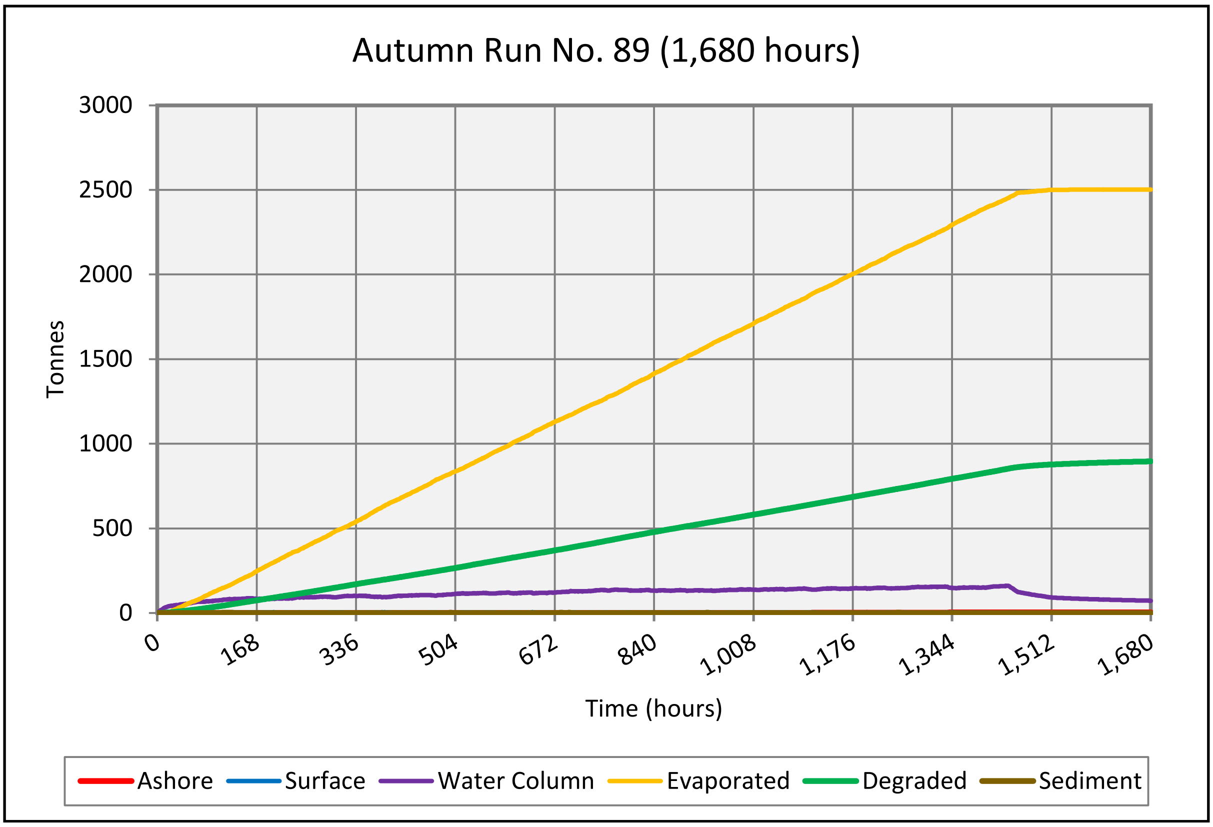
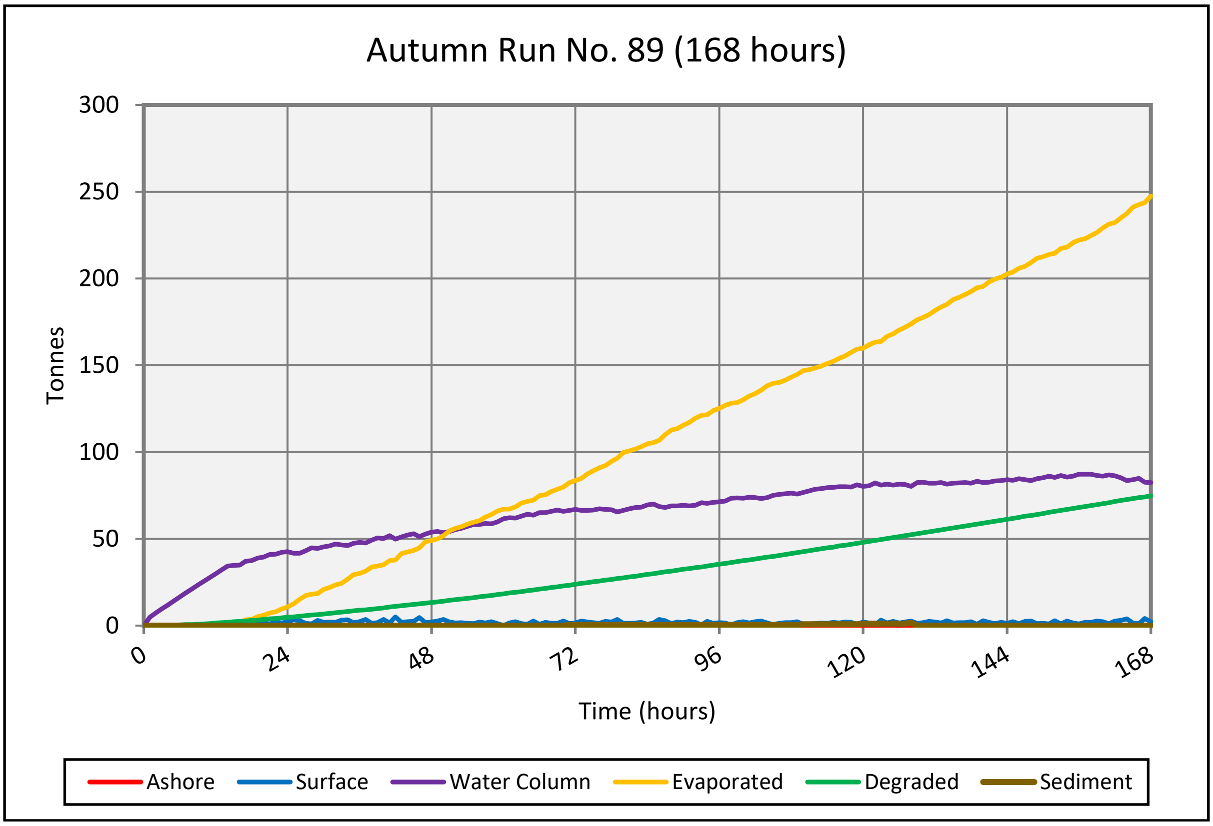


Figure B.20: Fate of the condensate released from Autumn Run No. 89 (showing first week of release)



Appendix C: Cuttings Dispersion Model

The modelling of cuttings deposition (from the 12.25 and 8.5 inch hole sections) on the seabed was completed using a simple analytical model based on the Stokes Law equations for particle settling velocity.

The model calculates the sinking rates of each particle size class, provided as input and calculates a location of seabed deposition based on hourly current speed and direction over a complete tidal cycle.

The model assumptions are:

- Particles are spherical;
- There is no initial velocity on discharge;
- Currents speed and direction is continuous for one hour and then changes instantaneously;
- There is no re-suspension of cuttings after initial deposition.

The model does not provide accurate seabed contours because contouring of the results of particle tracking models results in a significant over estimation of the amount of cuttings discharge. The model only provides an indication of the extent of the area of deposition.

Input parameters for the model are provided in Table C.1.

Table C.1: Discharge of Drill Cuttings from the 12.25 and 8.5 inch hole sections for the Victory Development Well

Parameters from the Victory Development Drilling	Data used in the Model
Weight of drill cuttings from the 12.25 and 8.5 inch sections (discharged at 10m below the surface)	159 tonnes
Current speed and direction	Section 4.2.3
Particle size distribution (size classes in mm)	0.1, 1, 5 and 10
Water depth	169.3 metres
Discharge depth (metres below the surface)	10 metres